FEDERAL AVIATION ADMINISTRATION

Draft Environmental Assessment

Noise Limitations for Aircraft Operations in the Vicinity of the Grand Canyon National Park NPRM

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This document was prepared by the Federal Aviation Administration as the lead agency with the Department of the Interior as cooperating agency.

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Table of Contents

CHAPTER ONE PURPOSE AND NEED

CHAPTER TWO ALTERNATIVES

CHAPTER THREE AFFECTED ENVIRONMENT

CHAPTER ONE PURPOSE AND NEED

National parks are unique national resources that have been provided special protection by law. The National Park Service (NPS) and Federal Aviation Administration (FAA) recognize that noise from commercial air tours and other flights over units of the national park system can adversely impact park resources, values and visitor experience. The proposed revisions to the Special Flight Rules in the vicinity of the Grand Canyon National Park (GCNP) are consistent with the missions of both FAA and NPS and legislative requirements to enhance the environment and protect the resources of national parks. The proposed revisions are to the newly adopted Subpart U of Part 93 of the Federal Aviation Regulations.

The Department of the Interior (DOI) has participated as a cooperating agency in preparation of this Environmental Assessment (EA) because of its role in overseeing the NPS. DOI has also participated in the rulemaking process as a cooperating agency.

The FAA and NPS have identified alternatives to reduce the impact of aircraft noise using quieter aircraft technology on the park environment. Proposed here is a noise efficiency concept based on certificated noise levels as an incentive for operators to utilize aircraft equipped with the best available noise abatement technology in the park. The use of fewer but quieter and larger aircraft would provide two-fold benefits in reducing noise of each operation and reducing the number of operations to carry the same number of passengers. For more details see NPRM noise efficiency methodology.

This has been accomplished through the US Department of Transportation (DOT) and DOI Interagency Working Group (IWG), an advance notice of proposed rulemaking (ANPRM) jointly issued by the FAA and NPS on March 17, 1994, (ANPRM of Overflights of Units of the National Park System, 59 Fed. Reg. 12740 et seq.) a public meeting in Flagstaff, Arizona on August 30, 1995, in Scottsdale, Arizona on September 17, 1996, and in Las Vegas, Nevada on September 20, 1996, and an abbreviated scooping process.

The IWG was formed because the Secretary of the Interior and the Secretary of Transportation concurred that increased flight operations at GCNP and other national parks have significantly diminished the national park experience for some park visitors, and that measures such as quiet technology can and should be taken to preserve a quality park experience for visitors, while providing access to the airspace over national parks. [1]

1.1 FEDERAL AVIATION ADMINISTRATION STATUTORY MISSION

The FAA is a modal administration of the DOT. The FAA is the lead agency in preparation of this EA because the FAA has sole authority for control of the airspace in the vicinity of the GCNP to ensure aviation safety and efficiency. The former Federal Aviation Act of 1958 (FAAct), as recodified at 49 USC 40101 et seq., has given the FAA broad authority and responsibility to regulate the operation of aircraft and the use of navigable airspace, and to establish safety standards for and regulate the certification of

airmen, aircraft, and air carriers. The FAAct provides additional guidance to include, among other things, regulation for safety and efficiency of both civil and military operations, promotion of the development of civil aviation, fulfillment of the requirements of national defense, and operation of a common system of air traffic control for civil and military aircraft. The FAA's authority to establish air traffic regulations to address adverse environmental impacts derives from 49 USC Sections 40103(b)(2) and 44715. Section 40103(b)(2) authorizes the FAA to prescribe air traffic regulations on the flight of aircraft for, among other things, "navigating, protecting, and identifying aircraft" and "protecting individuals and property on the ground." Section 44715 directs the FAA, after consultation with the US Environmental Protection Agency, to adopt such regulations as it deems necessary to control and abate aircraft noise, considering environmental, safety, economic reasonableness, technological practicability, and appropriateness for aircraft type, engine, or certificate. In administering transportation programs and projects, the FAA, as part of DOT, is also subject to a specific mandate to make special efforts to preserve the natural beauty of public park and recreation lands, wilderness areas, and wildlife refuges (49 USC 303). Under Section 8 of the Grand Canyon National Park Enlargement Act of 1975 (Pub. L. 93-620, 88 Stat. 2089) the FAA must consider the recommendations of the Secretary of the Interior and take appropriate action to protect the natural quiet and experience of the park and the health, welfare and safety of the visitors.

1.2 NATIONAL PARK SERVICE STATUTORY MISSION

GCNP is administered by the NPS of the DOI. NPS has jurisdiction by law over and special expertise relating to the lands, visitors and resources within the GCNP. NPS has also provided information about the affected environment used to prepare the EA and has provided technical review assistance.

The NPS is charged with managing the natural and cultural resources in the GCNP. The NPS Organic Act of August 25, 1916 created the NPS to promote and regulate national parks in accordance with the fundamental purpose of those parks, which is "to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (16 USC 1 et seq. and individual park enabling legislation). Subsequent legislation further states that any authorized activity "shall not be exercised in derogation of the values and purposes" of a park. Thus, the NPS states that "unimpairment" is joined by a responsibility to avoid derogation of the purposes and values of the national park system and its individual units. [2]

1.3 NATIONAL PARKS OVERFLIGHTS ACT

In 1987, Congress enacted Public Law (Pub. L. 100-91), commonly known as the National Parks Overflights Act. Pub. L. 100-91 stated, in part, that noise associated with aircraft overflights at GCNP was causing "a significant adverse effect on the natural quiet and experience of the park and current aircraft operations at the Grand Canyon National Park have raised serious concerns regarding public safety, including concerns regarding the safety of park users."

Section 3 of Pub. L. 100-91 required the DOI to submit to the FAA recommendations

to protect resources in the Grand Canyon from adverse impacts associated with aircraft overflights. The law mandated that the recommendations: (1) provide for substantial restoration of the natural quiet and experience of the park and protection of public health and safety from adverse effects associated with aircraft overflight; (2) with limited exceptions, prohibit the flight of aircraft below the rim of the canyon; and (3) designate flight-free zones excluding aircraft operations except for purposes of administration and emergency operations.

In December 1987, the DOI transmitted its "Grand Canyon Aircraft Management Recommendation" to the FAA, which included both rulemaking and nonrulemaking actions. Pub. L. 100-91 required the FAA to prepare and issue a final plan for the management of air traffic above the Grand Canyon, implementing the recommendations of the DOI without change unless the FAA determined that executing the recommendations would adversely affect aviation safety. After the FAA determined that some of the DOI recommendations would adversely affect aviation safety, the recommendations were modified to resolve those concerns. The FAA issued regulations implementing the final plan, Special Federal Aviation Regulation 50-2, on May 27, 1988 (53 FR 20262, June 2, 1988).

A second major provision of section 3 of Pub. L. 100-91 required the DOI to submit a report to Congress ". . . discussing . . . whether (SFAR 50-2) has succeeded in substantially restoring the natural quiet in the park; and . . . such other matters, including possible revisions in the plan, as may be of interest." The report was to include comments by the FAA "regarding the effect of the plan's implementation on aircraft safety." The Act mandated a number of studies related to the effect of overflights on parks. These efforts took longer than originally anticipated due to the complexity of the scientific issues involved.

On September 12, 1994, the DOI submitted its final report and recommendations to Congress. This report, entitled Report on Effects of Aircraft Overflights on the National Park System was published in July 1995. In its report, DOI concluded that SFAR 50-2 did not substantially restore natural quiet in the park, and therefore recommended numerous revisions to SFAR 50-2.

1.4 REGULATORY HISTORY

Beginning in the summer of 1986, the FAA initiated regulatory action to address increasing air traffic over GCNP. On March 26, 1987, the FAA issued Special Federal Aviation Regulation (SFAR) 50 (subsequently amended on June 15, 1987; 52 FR 22734) establishing flight regulations in the vicinity of the Grand Canyon. The purpose of the SFAR was to reduce the risk of midair collision, reduce the risk of terrain contact accidents below the rim level, and reduce the impact of aircraft noise on the park environment. On May 27, 1988, the FAA issued SFAR 50-2 revising the procedures for operations of aircraft in the airspace above the Grand Canyon (53 FR 20264, June 2, 1988). The SFAR 50-2 established a Special Flight Rules Area (SFRA) from the surface to 14,499 feet above mean sea level (MSL) in the area of the Grand Canyon. The SFAR prohibited flight below a certain altitude in each of five sectors of this area, with certain exceptions. The SFAR established four flight-free zones from the surface to 14,499 feet MSL above large areas of the park

The SFAR provided for special routes for commercial sightseeing operators, which are required to conduct operations under Part 135, as authorized by special operations specifications. Finally, the SFAR contained certain terrain avoidance and communications requirements for flights in the area. The newly proposed Subpart U would enlarge the SFRA and provide minimum altitudes in sectors and corridors to separate different types of operations to the maximum extent possible.[3] On June 15, 1992, the FAA promulgated a final rule to extend the expiration date of SFAR 50-2 to June 15, 1995, while the NPS studies and analyses required to prepare the report to Congress were being conducted (57 FR 26764).

The FAA published a final rule on June 15, 1995, that extended the provisions of SFAR 50-2 to June 15, 1997 (60 FR 31608). This action allowed the FAA sufficient time to review thoroughly the NPS recommendations submitted in its Report to Congress as to their impact on the safety of air traffic over GCNP, and the need to initiate and complete any appropriate rulemaking.

On July 31, 1996 (61 FR 40120), the FAA published an NPRM to reduce the impact of aircraft noise on Grand Canyon National Park (GCNP) and to assist the National Park Service (NPS) in achieving its statutory mandate imposed by Public Law 100-91 to provide for the substantial restoration of natural quiet and experience in GCNP. The NPRM proposed and requested comments on the following: (1) modification of the dimensions of the GCNP Special Flight Rules Area (SFRA); (2) establishment of new flight-free zones and flight corridors, as well as modification of existing flight-free zones and flight corridors; (3) proposed flight-free periods and/or an interim moratorium on additional commercial sightseeing air tours and tour operators; and (4) establishment of reporting requirements for commercial sightseeing companies operating in the SFRA. In addition to these areas, the FAA sought comment on a number of questions and alternatives regarding curfews and caps, as well as on the issue of quiet aircraft technology.

On August 20, 1996, the FAA published a Draft Environmental Assessment[4] (Draft EA) that provided preliminary assessment of the impacts of the NPRM in a limited impact assessment area, which included a sizable portion of GCNP, but also included non-park areas beyond the Special Flight Rules Area. The area was defined as a one-degree latitude by one-degree longitude area totaling approximately 2,300 square miles. It included GCNP Airport to the south, Fossil Canyon Corridor to the west, Desert View Flight-Free Zone to the east, and extended north just above the north rim. It encompassed Bright Angel and Desert No-Flight Zones as well as Dragon and Zuni Corridors.

Public Meetings

The FAA has held several public meetings in an effort to obtain public input for the development of additional actions to reduce the impact of aircraft noise on GCNP and assist the NPS in its efforts to restore natural quiet and experience in the park.

The FAA sponsored public meetings between September 16-20 in Scottsdale, Arizona and Las Vegas, Nevada to receive comments on the Draft EA for the Final Rule. These meetings were announced in the Federal Register on August 30[5] and in newspapers in Phoenix, Flagstaff and

Kingman, Arizona, and Las Vegas, Nevada, on several dates in early September. The Draft EA meetings were September 17 (Scottsdale) and 20 (Las Vegas). The meetings were conducted in conjunction with public meetings on September 16 and 20 to receive comments on the NPRM. Seven people spoke at the Scottsdale Draft EA meeting and 12 people spoke in Las Vegas. The speakers represented air tour operators, environmentalists, Native American tribes, and other individuals. Use of quiet technology aircraft, the need for an Environmental Impact Statement and environmental assessment requirements levied by the President's Council on Environmental Quality were new topics discussed by the commenters.

Consultation with Native Americans[6]

The DOT and DOI are committed to full consultation with tribal governments and have consulted directly with interested tribes. Consistent with consultation that occurred for the Final Rule establishing Subpart U issued December 31, 1996, in which quiet technology was discussed, FAA will continue consultation for purposes of this NPRM on whether to phase in quiet technology. Details of the legal requirements for consultation requirements and the process that FAA followed to date are provided in the Final EA for the Final Rule

Final Rule Special Flight Rules in the Vicinity of Grand Canyon

On December 31, 1996 the FAA issued the final rule that amends part 93 of the Federal Aviation Regulations by adding a new subpart, subpart U. Subpart U codifies and amends the provisions of Special Federal Aviation Regulation No. 50-2, Special Flight Rules in the Vicinity of Grand Canyon National Park. Specifically, the FAA modified the dimensions of the Grand Canyon National Park Special Flight Rules Area (SFRA); established new and modified flight-free zones; established new and modified flight corridors; and established reporting requirements for commercial sightseeing companies operating in the SFRA. In addition, to provide further protection for Park resources, subpart U contained flight-free periods within the Park and an interim moratorium on additional commercial sightseeing tour aircraft or tour operators. The FAA adopted these changes to reduce the impact of aircraft noise on the park environment and to assist the National Park Service in achieving its statutory mandate imposed by Public Law 100-91 to provide for the substantial restoration of natural quiet and experience in Grand Canyon National Park.

1.5 PURPOSE AND NEED

The purpose of the NPRM for which this draft EA has been prepared is to encourage the use of quieter aircraft technology in the Grand Canyon National Park to reduce further the impact of aircraft noise on the park environment. The study area relating to this objective is shown in Figure 1-1. This proposal would accomplish this purpose by a combination of requirements that would limit future use of noisier aircraft with incentives for the use of quieter aircraft. The effects of these measures are expected to substantially and permanently improve the noise environment in and around the Grand Canyon National Park.

The FAA recognizes the need to reduce the impact of aircraft noise on the environment and to assist the NPS in achieving the statutory mandate imposed by Pub. L. 100-

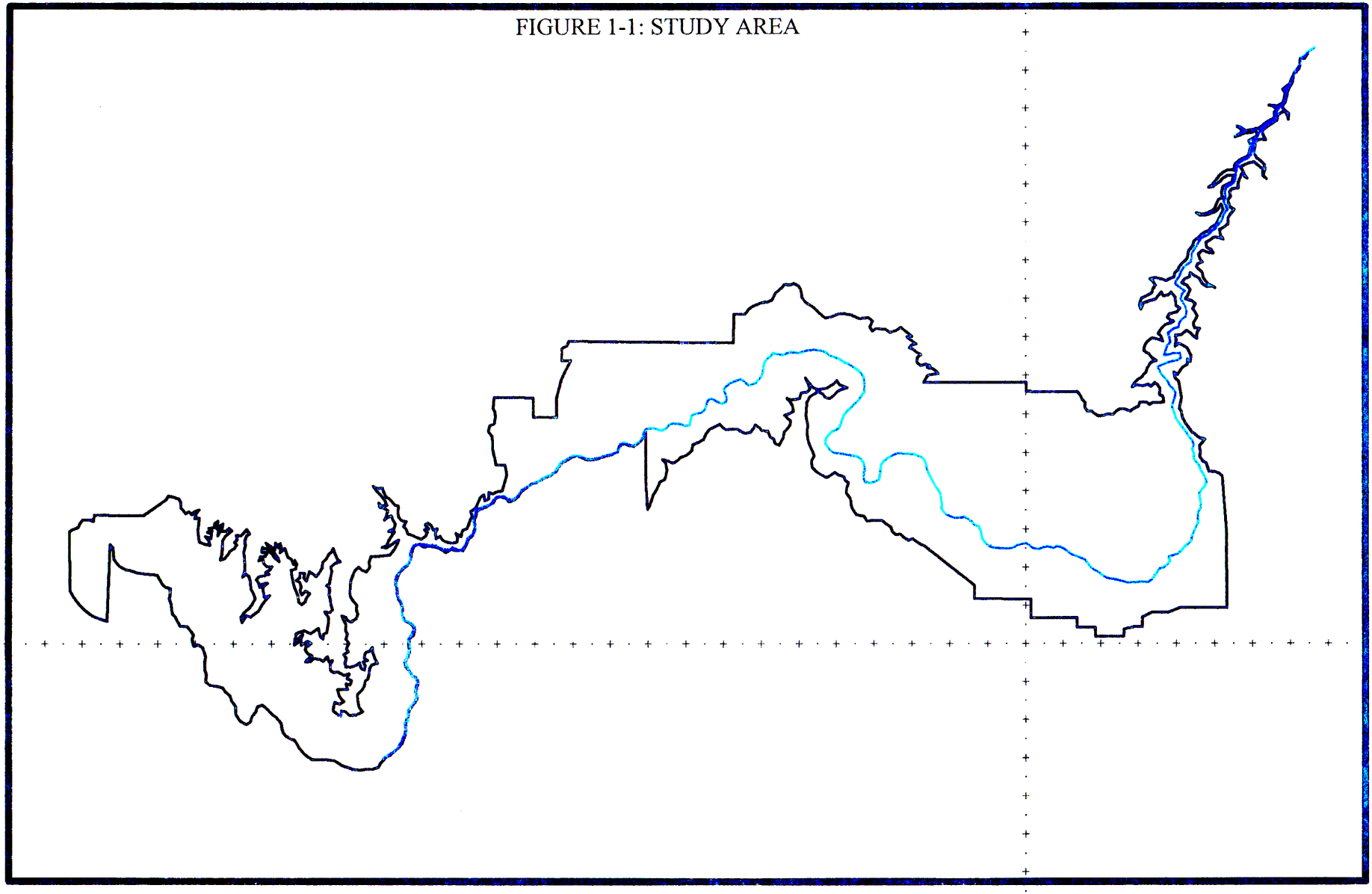
91 to provide for the substantial restoration of natural quiet and experience in Grand Canyon National Park.

Congress required the NPS to submit recommendations to FAA that would "provide for substantial restoration of the natural quiet and experience" of the GCNP (see Pub. L. 100-91). The purpose of the action is to reduce the impact of aircraft noise on the park environment and work toward its statutory mandate imposed by Pub. L. 100-91 to provide for the substantial restoration of natural quiet and experience in GCNP.

"[S]ubstantial restoration of natural quiet" has been defined by the NPS to mean "that 50 percent or more of the park achieve 'natural quiet' (i.e., no aircraft audible) for 75 to 100 percent of the day."[7] Natural quiet refers to the natural ambient sound conditions found in parks, referring to the absence of mechanical noise but accepting the non-mechanical "self-noise" of visitors (i.e., talking, walking, etc.). Using this definition, the final rule of December 31, 1996 has made substantial progress toward achieving the NPS goal of "restoration of natural quiet" at the GCNP. The NPRM is needed to complete this progress toward the "restoration of natural quiet" goal.

The DOT recognizes the NPS statutory mandate at the GCNP and the need to find a balance between preservation of park values and the efficacy of the air tour industry. The final rule and the NPRM represent major steps toward achieving the statutory mandate to provide for substantial restoration of natural quiet at GCNP.

FIGURE 1-1: STUDY AREA



[1] FAA/NPS ANPRM, 59 FR 12740, March 17, 1994

[2] This section largely derived from FAA/NPS ANPRM, 59 FR 12740, March 17, 1994.

[3] Flight corridors are areas established for pilot use in navigating the SFRA while avoiding flight-free zones. Prominent terrain features were chosen, where feasible, to assist pilots in navigating the corridors. The historical context of flight corridors is in the 1987 NPS Grand Canyon Aircraft Management Recommendation. The NPS proposed establishing flight corridors to provide: (a) an opportunity to fly over Grand Canyon to view the scenic vistas; (b) approximately 30- to 60-minute commercial sightseeing opportunities from GCNP Airport; and (c) avoidance of noise-sensitive locations within the park.

[4] FAA Draft Environmental Assessment, Special Flight Rules in the Vicinity of Grand Canyon National Park, August 20, 1996, Docket No. 28653.

[5] Federal Register, Volume 61, Number 170, August 30, 1996, page 45921.

[6] DOT/NPRM, Docket No. 28537; Notice 96-11, July 31, 1996, 61 FR 40123 .

[7] NPS Report to Congress on the Effects of Aircraft Overflights on the National Park System, July 1995, pg. 182.

CHAPTER TWO ALTERNATIVES

This chapter describes the identification of reasonable alternatives for this proposal, including an explanation of the reasons for not retaining alternatives for detailed study. In developing alternatives for this EA, the FAA was guided by its statutory mission and objectives, as well as those of the NPS, and by the purpose and need for the proposed action, as discussed in Chapter 1.

With regard to the alternatives for study, the FAA and NPS recognized that there are gaps in relevant information and scientific uncertainty. The lack of complete and available information concerning noise methodology, metrics, and the proper definition of substantial restoration of natural quiet, was documented in our preliminary comments on the NPS Report to Congress. Although both agencies recognize that there are unresolved issues, the FAA and NPS have determined that it is in the public interest to proceed with this rulemaking. Both agencies deem this rulemaking important for substantially restoring the natural quiet in the Grand Canyon National Park (GCNP), as required under the National Park Overflights Act.

This Draft EA evaluates the environmental effects of the No Action Alternative and the NPRM. See FAA Order 1050.1D, Policies and Procedures for Considering Environmental Impacts. The Final EA will evaluate the impacts of quiet technology aircraft proposed in the NPRM in the vicinity of GCNP in 1996 and future years, as well as socio-economic impacts. See, 40 CFR 1502.22. (Because a standard for determining adverse impacts of aircraft overflights on national parks has not been established, the guidance in this regulation, which explicitly governs EISs, is also appropriate for use in this EA.)
This Draft EA will be circulated for comment to the persons listed in Appendix A, and a copy will be placed in the docket of the NPRM. The preamble to the NPRM also invites comments on this Draft EA, and indicates how additional copies can be obtained.

Based on the Final EA of this proposal, the FAA will determine whether a finding of no significant impact may be issued or an environmental impact statement may be required.

2.1 IDENTIFICATION OF POTENTIAL ALTERNATIVES

The FAA and NPS have identified alternatives to reduce the impact of aircraft noise on the park environment. This has been accomplished through:

- the DOT and DOI IWG;
- an ANPRM jointly issued by the FAA and NPS on March 17, 1994, (ANPRM of Overflights of Units of the National Park System, 59 Fed. Reg. 12740);
- an NPRM issued on July 31, 1996 (61 FR 40120);
- a draft EA, Special Flight Rules in the Vicinity of Grand Canyon National Park, issued on August 20, 1996;
- a Final Rule and Final EA issued December 31, 1996 and
- public meetings in Flagstaff, Arizona, on August 30, 1995, in Scottsdale, Arizona, on September 17, 1996, and

in Las Vegas, Nevada, on September 20,1996.

The proposed action continues the Federal government's efforts to reduce aircraft noise impacts over sensitive portions of GCNP. During this process, consultation has occurred with Federal, State and tribal agencies and with the public. Over 14,000 comments were received in response to the July 31, 1996, NPRM and related public meetings. The flight rules proposed in that NPRM were finalized on December 31, 1996 with the release of the Final Rule. Basically, that final rule amends Part 93 of the Federal Aviation Regulations by adding a new subpart to codify the provisions of Special Federal Aviation Regulation No. 50-2, Special Flight Rules in the Vicinity of Grand Canyon National Park; modifies the dimensions of the Grand Canyon National Park Special Flight Rules Area (SFRA); establishes new and modified flight-free zones; establishes new and modified flight corridors; and establishes reporting requirements for commercial sightseeing companies operating in the SFRA. In addition, to provide further protection for Park resources, the final rule establishes flight free periods for those commercial sightseeing operations being conducted in the Dragon and Zuni Corridors and limits the number of aircraft used for commercial sightseeing operations in the Grand Canyon Special Flight Rules Area.

In response to comments in the docket and those made at public hearings, FAA redoubled its efforts to develop concepts which would provide incentives for tour operators to invest in the best available noise abatement technology. Traditionally, the FAA uses its regulatory authority to impose more stringent national noise standards when these have been determined to be appropriate. By law when deciding on further noise stringency, FAA must ascertain whether the proposal is technologically feasible, economically reasonable, and appropriate to aircraft type. Based upon a joint FAA/NASA research report to Congress on quiet technology and earlier work prepared for the third meeting of the Committee on Aviation Environmental Protection (CAEP) under the International Civil Aviation Organization (ICAO), the FAA determined that the imposition of new national and international noise standards for propeller-driven small airplanes and helicopter is not appropriate at this time. While there is ongoing research by the Federal government to identify future noise abatement technology, current aircraft designs already incorporate most of the available technology within economic reasonableness. Therefore, FAA looked to non-traditional concepts which could offer some incentive for tour operators to improve the GCNP situation.

A number of the comments received during development of the final rule concerned the issue of quiet aircraft technology, and noted that the use of quieter, larger aircraft would provide two-fold benefits by reducing the noise of each operation and reducing the number of operations to carry the same number of passengers. Those comments are discussed in greater detail in the preamble to the NPRM.

The FAA agrees that the use of quiet aircraft technology will, in the long run, provide the most benefit toward restoring the natural quiet. This theme fits in nicely with the FAA's general policy of using cumulative aircraft noise exposure as an appropriate measure of the potential impact. The FAA began to explore noise efficiency concepts as an incentive for operators to utilize aircraft equipped with the best available noise abatement technology in the park. The

following attributes were used in judging potential concepts:

- Is based on aircraft noise certification (14 CFR Part 36)
- Judges fixed- and rotary-wing aircraft on a common basis
- Correlates with aircraft performance and operation at GCNP
- Offers basis for incentives
- Is manageable.

The FAA's consideration of these and related technical factors is described in considerable detail in the preamble to the NPRM. This consideration led FAA to identify the proposal as the action that would best encourage the implementation of quiet technology aircraft.

The NPRM contains a phase-out schedule for older, noisier aircraft, a requirement that newly acquired aircraft meet acoustic criteria, and an incentive for using quieter aircraft by allowing flights through the National Canyon route to be conducted with only the aircraft that meet the acoustic criteria.

In order to implement the phase-out of older noisier aircraft, the proposal divides aircraft into Categories A, B, and C, with Category A being the noisiest and Category C being the quietest[1]. (see Table 2.1). Category A will be phased out on or before December 31, 2000. Category B will be phased out on or before the year 2008. As part of the phase-out, the proposal would allow an operator to replace a Category A aircraft with a Category B or C aircraft on or before December 31, 2000.

FAA also considered an alternative that would have required operators of Category A aircraft to move directly to Category C aircraft and would have precluded them from replacing a Category A aircraft with a Category B aircraft. If all operators remained in business for both scenarios through 2008, there would be an estimated additional cost (differential) associated with requiring aircraft to move directly from A to C. The more significant aspect is, however, that there would be a major cost differential during the first four years by requiring "A" aircraft to move directly to "C". This is true because it would be much more expensive to purchase "C" aircraft than "Bs" as the "A" aircraft are phased out.

The FAA discarded this alternative because it would have imposed a significant financial burden on a number of small companies in the short term. In addition, this alternative would produce no noise benefit by the year 2000 because of the availability of the Grand Canyon incentive track in 1997 to an increased number of aircraft, albeit in Category C. Since much of the incentive track is located within the GCNP boundaries, the associated noise levels increase with respect to NPS goal of restoring natural quiet within the park boundary. The proposed action and the discarded alternative would produce the same noise benefit by the year 2008.

While the proposed phase-out of the less noise-efficient aircraft would serve as the centerpiece of the subsequent comprehensive noise management plan, both the FAA and NPS agree that certain fine-tuning may be necessary, especially in view of future technological changes and after a review of the operating experience. Accordingly, a comprehensive noise management plan will be jointly developed to provide a long-term solution that would maximize the gains in noise reduction and substantial restoration of natural quiet attributed to the phase-out. It will address the best available technology, a monitoring program for noise and

operations, provision of appropriate incentives for investing in quieter aircraft, appropriate treatment for commercial sightseeing operators that have already made such investments, and a more adaptive management system.

Approaches for reducing aircraft noise, that consider both the noise emission level of aircraft and the number of operations, will be reviewed and evaluated for development of the noise management plan. The plan will address a number of factors, including the utilization of quieter aircraft in the SFRA, appropriate incentives for investment in quieter aircraft, and treatment of quieter aircraft that currently operate in the SFRA. Approaches that will be considered in developing the plan will include, but would not be limited to, noise budgets, a cap on the number of commercial sightseeing aircraft in each operator's fleet that would be adjusted based on fleet conversion to quieter aircraft, and noise slots. The NPRM solicits comments on the types of considerations that should be included in this plan. FAA and NPS are both committed to the development of this plan over the next 5 years.

In accordance with NEPA, the No Action Alternative, which includes the changes made in the final rule, has been identified for detailed study in this Draft EA in addition to the NPRM proposal.

2.2 APPLICABLE STATUTES AND IDENTIFICATION OF REASONABLE ALTERNATIVES

FAA Order 1050.1D requires FAA, in an EA, to rigorously explore and objectively evaluate all reasonable alternatives as is required in an environmental impact statement, but in less detail, Paragraph 35, FAA Order 1050.1D. As described in Chapter 1, the noise limitations for aircraft operations are proposed, in part, because the FAA recognizes the opportunity to make changes that will improve the noise environment over GCNP. Statutory and regulatory requirements also affect the selection of alternatives. Statutory FAA and NPS agency missions (see Sections 1.1 and 1.2) direct agency responsibilities and priorities. Further, the GCNP is a World Heritage Site protected under the Convention Concerning the Protection of the World Cultural and Natural Heritage, ratified by the Senate on October 26, 1973, and implemented under 36 CFR part 73 pursuant to the National Historic Preservation Act Amendments of 1980. It is also a National Natural Landmark established under the Historic Sites Act. In addition, many sites within the park are eligible for, or listed on, the National Register of Historic Places under sec. 100 of the National Historic Preservation Act of 1966, as amended, and some are National Historic Landmarks (36 CFR Parts 62 and 65). Many contain sacred sites requiring consultation under the American Indian Religious Freedom Act of 1978. Several are designated, or are eligible for designation, as Wild and Scenic Rivers under the Wild and Scenic River Act or as Wilderness Areas under the Wilderness Act of 1964.

The reasonable alternatives retained for detailed study are described, in detail, below.

2.2.1 Alternative 1 -- No Action

The No Action alternative would involve maintaining the requirements and limitations contained in the final rule which are codified in Part 93, Subpart U, of Title 14 CFR. Briefly, these include:

- the provisions formerly contained in SFAR 50-2 which establish rules to reduce the risk of midair collision,

reduce the risk of terrain contact accidents below the rim level, and reduce the impact of aircraft noise on the park environment;

- modified dimensions of the Grand Canyon National Park Special Flight Rules Area (SFRA);
- establishment of new, or modification of existing flight free zones;
- establishment of new, or modification of existing flight corridors;
- reporting requirements for commercial sightseeing companies operating in the SFRA;
- establishment of flight-free periods for those commercial sightseeing operations being conducted from the Grand Canyon National Park Airport;
- limits on the number of aircraft used for commercial sightseeing operations being conducted in the SFRA.

2.2.2 Alternative 2 -- FAA/NPS Proposal (Proposed Action)

FAA in the NPRM proposes to amend Part 93 of the Federal Aviation Regulations by adding provisions establishing noise limitations for aircraft operations in GCNP.

As previously stated, the purpose of this proposal is to establish additional noise limitations to reduce further the impact of aircraft noise on the park environment in GCNP. This proposal would accomplish this goal by a combination of requirements that would limit future use of noisier aircraft and provide incentives for the use of quieter aircraft.

In order to be able to base a rule on aircraft noise efficiency, the FAA has evaluated the noise exposure of existing aircraft used in the GCNP and has divided those aircraft into three categories (see Figure 2-1). These categories were established using a concept of noise efficiency or noise per passenger seat. GCNP Category A aircraft includes the least noise efficient aircraft currently in use for sightseeing operations in the vicinity of the Grand Canyon National Park; GCNP Category B aircraft includes aircraft less noisy than Category A aircraft but noisier than the quietest aircraft now available; and GCNP Category C aircraft includes affected aircraft which have the highest noise efficiency currently available. See Table 2.1. A detailed discussion of the technological basis for these categorizations is contained in the preamble to the NPRM.

The proposal would in effect prohibit any further acquisition of GCNP Category A aircraft by persons conducting sightseeing operations for use in the SFRA. Current operators with Category A aircraft could continue to use the number of aircraft listed on the operator's operations specifications on [December 31, 1996], but that use would have to end on or before December 31, 2000. During the period of time after the effective date of a final rule and on or before December 31, 2000, an operator could replace Category A aircraft with Category B or C aircraft but only on a one-for-one basis.

Current operators of Category B aircraft would be allowed to continue to use that number of aircraft, but would be required to phase out that use entirely on or before December 31, 2008. The proposed phase out schedule would require that on or before December 31, 2002, at least one-quarter of the Category B aircraft listed on the operator's operations specifications on December 31, 2000, (the base level) would have to be phased out. The remaining Category B aircraft would have to be phased out in 25 percent increments so that no more than 50 percent of the base level aircraft would be in use after December 31, 2004, 25 percent after December 31, 2006, and all

Category B aircraft would have to be phased out on or before December 31, 2008.

While the proposed rule would allow the continued use of Categories A and B aircraft by current certificate holders as described above, all aircraft used by new entrants to the affected sightseeing area would have to meet Category C requirements. This means that any person who wants to establish an aircraft sightseeing operation in the affected area after the effective date of a final rule would have to use only Category C aircraft. Also, all new aircraft acquired by present operators over the total number of Category A and B aircraft listed on the operations specifications on [December 31, 1996], would have to be Category C aircraft.

In addition to the phase out of noisier aircraft as described above, this proposal would create an incentive to encourage the purchase of Category C aircraft by establishing a new corridor that could be used only by Category C aircraft.

The companion final rule expands the Toroweap/Shinumo Flight-free Zone to prohibit operations in the airspace area that is now used by operators for commercial sightseeing operations while flying from Las Vegas to Tusayan. This proposed NPRM would established a corridor, referred to as the National Canyon Corridor, within the newly expanded Toroweap/Shinumo Flight-free Zone that would enable GCNP Category C aircraft to reinitiate commercial sightseeing operations along this route from Las Vegas to Tusayan without having to circumnavigate the Toroweap/Shinumo Flight-free Zone.

This proposal is described in greater detail in the preamble of the NPRM.

Under the companion final rule, an immediate temporary cap is placed on the number of aircraft permitted to be used by each operator for commercial sightseeing operations in the Grand Canyon SFRA. If this notice is adopted as proposed, a cap on the total number of Category A and Category B aircraft permitted to operate in GCNP would remain in effect. However, the cap on Category C aircraft would be lifted. As a result, the fleet size of Category C aircraft could grow, subject to safety considerations, market-based considerations, or recommendations from the comprehensive noise management plan.

2.3 EVALUATION OF REASONABLE ALTERNATIVES

This section summarizes the environmental effects described in Chapter 4, Environmental Consequences for each alternative.

2.3.1 Alternative 1 -- No Action

The noise analysis presented in Chapter 4 describes the No Action alternative as the conditions which will occur after implementation of the final rule, and which, thereafter, would remain unchanged. With this alternative, no further changes would be made to affect the noise conditions in the GCNP. No further reduction in aircraft noise or its effects would occur. Over time, more areas would be expected to be affected by increasing aircraft noise if operators are not encouraged to use quieter aircraft.

This alternative would provide no further improvement in the effects of aircraft noise on: ritual and traditional use areas, historic, cultural, and archeological resources; uses under Section 4(f) of the DOT Act, as amended (recodified at 49 USC 303) (DOT

Section 4(f)); wild and scenic rivers; wilderness areas; and visual impacts. There would be no further economic impacts, beyond those associated with the implementation of the final rule.

Based on the analysis in Chapter 4 within the initial impact analysis area and without considering forecast activity, no further appreciable change in aircraft noise levels would be expected to occur under this alternative.

2.3.2 Alternative 2 -- FAA/NPS Proposal (Proposed Action)

The proposed action would reduce the impacts of aircraft noise by phasing out noisier aircraft and providing incentives for the use of quieter aircraft. The noise analysis contained in Chapter 4 demonstrates that implementation of the proposed action would generally reduce aircraft noise throughout the GCNP and vicinity, except for increases at a few locations. Most importantly the proposed action would meet the National Park Service goal for natural quiet by the year 2000 and would substantially surpass the National Park Service goal by the year 2008.

Accordingly, the overall effect of the proposed action will be to reduce the effects of aircraft noise within the impact analysis area on areas of historic, cultural, or archeological importance, and on wild and scenic rivers. No significant adverse effects are expected within the impact analysis area on DOT 4(f) uses, visual resources, or Native Americans, or wilderness areas.

Preliminary review by the FAA indicates that the proposed action would impose some adverse economic impacts on small commercial air tour operators that provide sightseeing flights over the Grand Canyon. These are discussed in Chapter 4 and in the preamble to the NPRM, and in greater detail in the regulatory evaluation prepared for the NPRM.

2.4 COMPARISON OF REASONABLE ALTERNATIVES

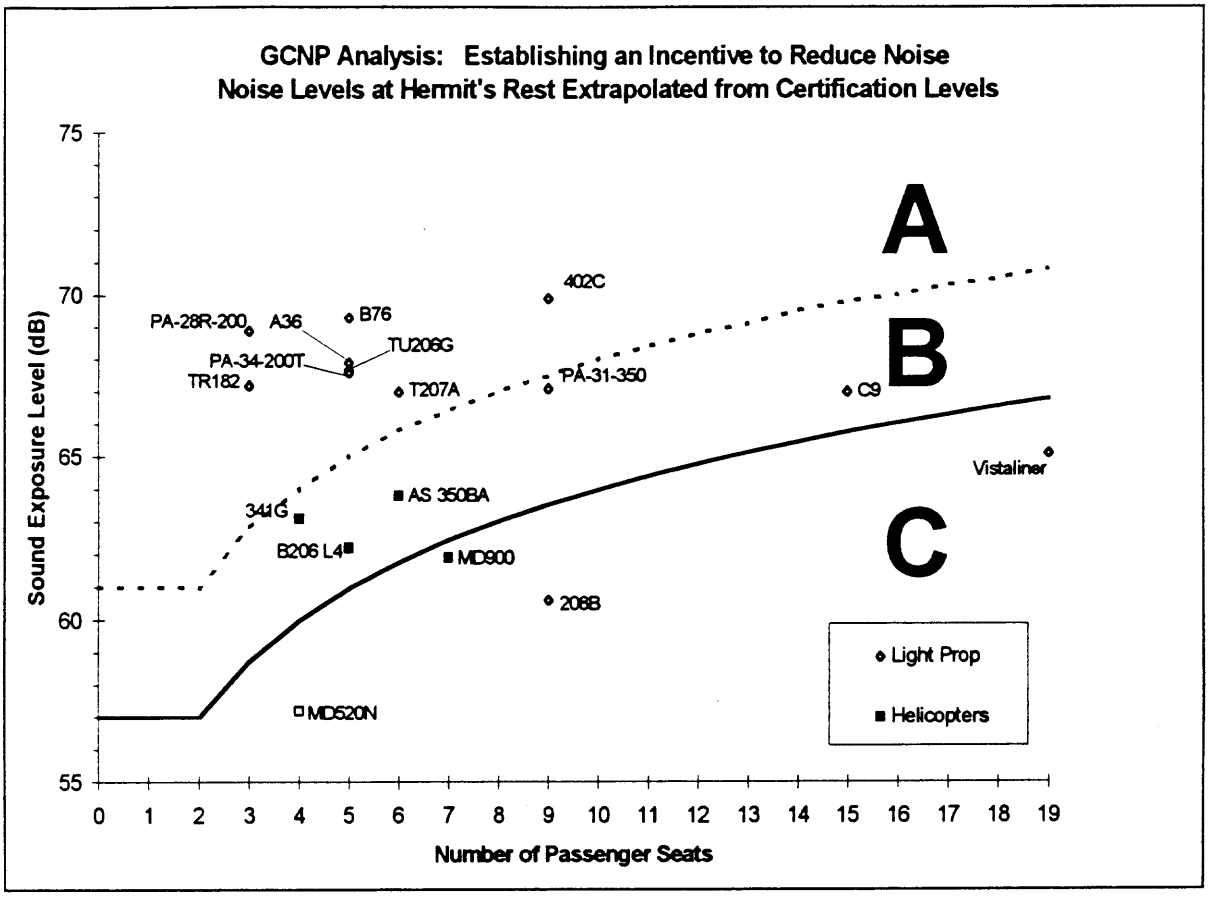
Paragraph 64 of FAA Order 1050.1D requires the EA to "present the environmental impacts of the proposal and alternatives in comparative form." Accordingly, this section compares the relevant environmental effects of the No Action and FAA/NPS proposal alternatives.

The No Action alternative would result in no significant adverse environmental effects. It would not create any further reduction in the adverse impacts of aircraft noise over the initial impact analysis area of GCNP and would not impose any further economic impacts. The proposed action would result in no significant adverse environmental effects. It would reduce the aircraft noise on the park environment in the GCNP, but would impose some economic impacts on small air tour operators.

Table 2.1 Categories of Aircraft Operating in GCNP[1]

Category	Aircraft Operating in GCNP
Light Props	
A	Beechcraft A36 (Bonanza)
A	Cessna 180
A	Cessna 206 (Stationair)
A	Cessna 207 (TurboStationair)
A	Cessna 402 (Businessliner)
B	Cessna R182 (Skylane)
B	Beechcraft BE99
B	Piper 31-350 (Navajo)
C	Cessna 208 (Caravan)
C	DeHavilland DHC-6-300 (Vistaliner)
Helicopters	
B	Aerospatiale 341 (Gazelle)
B	Aerospatiale 350 (Astar)
B	Bell 206L/B (LongRanger/JetRanger)
C	McDonnell-Douglas MD520 (NOTAR)
C	McDonnell-Douglas MD900 (NOTAR)

Figure 2-1


GCNP Analysis: Establishing an Incentive to Reduce Noise
Noise Levels at Hermit's Rest Extrapolated from Certification Levels
Sound Exposure Level (dB)
75
70
65
60
55
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
Number of Passenger Seats
A
B
C
PA-28R-200
A36
B76
TU206G
PA-34-200T
TR182
T207A
402C
PA-31-350
C9
Vistaliner
341G
AS 350BA
B206 L4
MD900
208B
MD520N
Light Prop
Helicopters

[1] FAA technicial paper "Methodology to Categorize the Noise Efficiency of Air Tour Aircraft in GCNP" is available at the FAA public docket.

CHAPTER THREE AFFECTED ENVIRONMENT

The description of the affected environment focuses on characteristics of Grand Canyon National Park (GCNP) relevant to the adoption of quiet aircraft technology and the anticipated environmental impacts of the proposed action and the no action alternative. Noise is the primary impact from aircraft overflights. As discussed in more detail in Chapter 4, noise at levels being considered here may affect the following impact categories from FAA Order 1050.1D: historic/archaeological/cultural resources; DOT Section 4(f); and wild and scenic rivers. In addition, effects on Native American communities and wilderness will be addressed.

Much of the information in the following sections is taken from the National Park Service (NPS) General Management Plan Draft Environmental Impact Statement (DEIS) for the GCNP. This was made final in July 1995 and a record of decision issued in August 1995.

3.1 REGIONAL CONTEXT

GCNP is a unique natural and cultural resource which attracts approximately five million visitors from around the world annually who view the canyon from motor vehicles, foot, mule, river boat, or air. It is designated as a World Heritage Site. The area potentially affected by the alternatives includes lands within the SFRA boundary (as shown in Figure 1-1). The following sections describe GCNP and its surrounding areas.

The 1995 GCNP General Management Plan/Environmental Impact Statement contains detailed information about the GCNP. GCNP lies within Coconino and Mohave Counties in the state of Arizona and is located close to the states of Utah and Nevada. The park is bounded on the north by Kaibab National Forest and the Bureau of Land Management's Arizona Strip District, on the northeast by Glen Canyon National Recreational Area, on the east by the Navajo Indian Reservation, on the south by Kaibab National Forest and the Hualapai and Havasupai Indian Reservations, and on the west by Lake Mead National Recreation Area.

Coconino County, Arizona contains the three main entrances to Grand Canyon National Park and the communities most directly affected by the social and economic effects of park operations. Most South Rim visitors spend at least one night in Coconino County. Communities in Coconino County and Utah's Kane and Washington counties are service areas for visitors to the North Rim and Tuweep. Coconino County is the second largest county in area in the United States. In addition to encompassing much of the area of Grand Canyon National Park, it contains all or portions of the Navajo, Hopi, Havasupai, Hualapai, and Kaibab Paiute Indian reservations.[1] The Kaibab Paiute Indian reservation, located at the Arizona-Utah border, does not bound any portion of the GCNP and is outside the affected area. Tribes however, maintain an ancestral interest in portions of the GCNP.

3.2 GRAND CANYON NATIONAL PARK

GCNP encompasses 1.2 million acres of the Grand Canyon of the Colorado River in northern Arizona (see Figure 1-1). The Colorado River, running westerly 277 miles within the park from Lees Ferry to the Grand

Wash Cliffs, divides the park into north and south sections. The canyon itself ranges from 1 to 18 miles wide and is over one mile deep in places. The park lies entirely on the southern portion of the Colorado Plateau. The higher elevations of the plateau are forested, while the lower elevations are a series of desert basins or deeply incised canyons. The park ranges in elevation from 1,200 feet on the canyon floor at the western end to over 9,000 feet on the North Rim. On both rims, the topography is generally flat, making land travel relatively easy. In contrast, topography below the rims is characterized by steep talus slopes, precipitous cliffs, crumbly decomposing rock ledges, and long narrow side canyons.

GCNP contains significant examples of most of the natural themes represented within the Colorado Plateau physiographic region, including: plains, plateaus, and mesas; work of volcanism; sculpture of the land; river systems and lakes; geologic history; boreal forest; and dry coniferous forest and woodland. The Grand Canyon also offers a geologic record covering the first three eras of geological time (2.5 billion years) making it one of the most complete records of geological history found anywhere in the world. These attributes are the primary reason why the GCNP is a World Heritage Site.

GCNP served 4,928,509 visitors in 1993 and has both undeveloped (natural) and developed areas as defined by the NPS.[2] The majority of the park is part of the NPS Natural Management Zone comprised of proposed wilderness areas and non-wilderness areas and trails. Each of the developed areas (South Rim, North Rim, Tuweep, and the corridor trails) tend to have unique characteristics.[3] These characteristics are generally related to the level of development. The major areas most relevant to this study are briefly described below.

3.2.1 South Rim

The South Rim is located on the eastern end of GCNP, just north of the town of Tusayan. According to the park's General Management Plan, the South Rim will remain the focus for most park visitors, but while it will continue to accommodate over 90% of the visitors to the entire park, limits will be placed on the number of people who can visit the South Rim at any one time.[4] The South Rim will also continue to provide diverse opportunities to view the canyon and to experience solitude in natural settings as well as social exchange in developed areas.[5] While the visitor experience on the South Rim is to a large extent currently oriented around the automobile, the General Management Plan calls for limits on the number of vehicles parking on the South Rim, restricting private vehicles from many areas, and encouraging visitors to use transit, pedestrian paths, and bicycles for their primary access.[6] The South Rim includes Grand Canyon Village, Desert View, Hermit's Rest, and numerous rim viewpoints.

3.2.2 North Rim

The North Rim is also located on the eastern end of GCNP, approximately ten air miles north of (and across the canyon from) the South Rim. The park's General Management Plan calls for the North Rim to provide a low-key, uncrowded atmosphere that offers visitors opportunities to be intimately involved with the environment. Under the General Management Plan, the North Rim will continue to accommodate less than ten percent of the park's visitors, a day visitor reservation system will be

implemented, and roads into the North Rim will continue to be closed to vehicles during the winter. Also, more visitors will be encouraged to visit the area between Point Imperial and Cape Royal to relieve congestion in the Bright Angel Point area, and to continue to visit Point Sublime via dirt road. (see Figure 1-1)

3.2.3 Marble Canyon

Marble Canyon is a narrow arm of GCNP through which the Colorado River enters GCNP. Marble Canyon extends northward from the North Rim about 40 air miles to Lees Ferry. The GCNP boundary is less than five air miles wide for the length of Marble Canyon. (see Figure 3-1)

3.2.4 Tuweep

Tuweep lies approximately 50 air miles to the west and 15 air miles north of and on the opposite side of the canyon from Grand Canyon Village. Tuweep served approximately 11,000 visitors in 1993. It is unique within the Grand Canyon because it is remote yet provides unpaved car access. NPS goals for this area are that it "continue to provide uncrowded, primitive experiences that are dominated by nature and solitude," including minimal visitor facilities.[7] Toroweap overlook is a prime visitor site in this area. In addition, Tuweep Airstrip, a state-owned strip with an unpaved 3,500 foot runway, is located approximately five air miles north of Toroweap Overlook and immediately adjacent to the park boundary. Tuweep is not within the initial impact analysis area.

3.2.5 Inner Canyon

The Inner Canyon includes about 90% of the park area, including most of the backcountry trails and campsites in the park, and the Colorado River. The park's General Management Plan calls for managing almost all of the Inner Canyon as wilderness. Exceptions include the Cross-canyon Corridor which includes Phantom Ranch and the other developed sites below the rim, and the Colorado River, which is to be managed to provide a wilderness river experience but that objective will not affect decisions regarding the use of motorized boats on the river. (see Figure 1-1)

3.3 CLIMATIC CONDITIONS

The climate at the Grand Canyon is diverse and directly affects flights over the area. This is due to elevation changes and to the unique effect the canyon itself has on weather.

GCNP experiences weather extremes during both summer and winter. In the context of air tour activity and aircraft overflights, summer conditions (May 1 - September 30) are generally more critical for several reasons. First, more tourist and resultant air tour activity occurs during the warm season. Second, aircraft performance tends to be decreased during hot weather. This makes hot weather aircraft performance parameters critical when evaluating noise abatement options. Hot conditions also tend to require pilots to increase aircraft engine speed to generate the additional thrust needed to offset decreased hot air performance. Increased engine speed generally results in greater noise emissions. Third, the propagation characteristics of noise tend to be affected by hot conditions such that sound travels farther.

In the summer at the North Rim, days are generally clear and crisp with occasional afternoon thunderstorms or heavy rain.

Evenings are chilly. Average summer high and low temperatures are 75 and 43 degrees Fahrenheit, respectively. The North Rim receives more precipitation than any other location in the park, with an average of 25 inches per year, respectively.

During the summer at the South Rim, afternoon thundershowers and occasional heavy rains can be expected. Average summer high and low temperatures are 82 and 51 degrees Fahrenheit, respectively.

At Phantom Ranch (at the bottom of the canyon) daytime temperatures are extremely high during the summer months, with highs and lows averaging 106 and 78 degrees Fahrenheit.

Summer days in the Grand Canyon region are warm and turbulent. Thunderstorms develop almost daily over some parts of the region from late June through early September as a result of local convectional disturbances due to excessive heating of the ground. These storms can be frequent, heavy and violent, but are usually localized. Turbulence, hail, rain, snow, lighting, severe updrafts and downdrafts, and icing conditions are all associated with these thunderstorms. The storms usually last less than 30 minutes but pilots must modify their flight routes to avoid such weather. The FAA recommends that pilots stay at least 10 to 20 miles away from thunderstorms.

"Density altitude" is also a factor which must be considered in developing management alternatives involving aircraft. It is a measure of air density which is used by pilots as an index in calculating the performance capability of aircraft. Density altitude becomes a critical factor in all warm-weather and high-altitude flight planning. High density altitude is a hazard since it reduces all aircraft performance parameters. Elevation (or altitude), humidity, and temperature all determine air density. When all three are high, density altitude is high and normal horsepower output is reduced, propeller and wing efficiency decrease, an airplane requires a longer takeoff roll before becoming airborne. Additionally, rate-of-climb is decreased, and a higher true airspeed is required. Flights are sometimes planned for the early morning or late afternoon hours to offset the effects of density altitude, as well as to take advantage of decreased turbulence.

Turbulence in the Grand Canyon is usually caused by differential heating of the canyon's surface or by strong winds. Updrafts caused by differential heating are often used by pilots to assist aircraft in climbing out of the canyon, sometimes a difficult task on a hot summer day when an aircraft is fully loaded. Canyon flying is much like mountain flying, and abrupt changes of wind direction and velocity must be anticipated.

Winter conditions are also extreme and vary widely. The North Rim is closed during the winter due to as much as ten feet of snow. Average winter high and low temperatures are 39 and 18 degrees Fahrenheit, respectively.

The South Rim is always open, generally receiving less than 3 feet of snow. Average winter high and low temperatures are 43 and 20 degrees Fahrenheit, respectively.

Winters at Phantom Ranch are also mild with maximum temperatures averaging 56 degrees Fahrenheit and the lows rarely dipping below freezing. The canyon below the rims receives about eight inches of precipitation each year.

During winter months, the Grand Canyon region experiences snowstorms and low-level stratus clouds. There are also short periods of temperature inversions, when clouds fill the canyon (cold air drains into and is trapped within the canyon) while the rims are being warmed by direct sunshine.

3.4 PHYSICAL RESOURCES

The Grand Canyon has a diversity of topographical and geological features. It also holds a historical record dating back millennia. This section, as well as Section 3.6.2, describes these physical and cultural resources. These characteristics affect the distribution of visitors and the expectation of the experience at various sites. Moreover, certain areas tend to be more sensitive to aircraft noise. The difference in elevation may also affect aircraft performance at different park locations.

3.4.1 Popular Trails and Sights

Most visitors to the Grand Canyon arrive at the South Rim. The majority of visitors view the canyon from the rim but do not explore the canyon below the rim. Of those that venture onto the corridor trails (the trails which provide main visitor access to destinations below the rim and connect the North and South Rims), most are day-hikers. Day-hikers hike a short enough distance to allow their return to the canyon rim before sunset. The primary trails are the North and South Kaibab Trails and the Bright Angel Trail.[8] In addition, the inner canyon trails which receive the most use outside the corridor include the Hermit, Grandview, Tanner, South Bass, Hance/Red Canyon, and Thunder River Trails.

Within the impact analysis area (depicted in Figure 1-1), popular sites include Hermit's Rest (on the South Rim) Bright Angel Point, Phantom Ranch, Point Sublime, Point Imperial, Toroweap Point, and Supai Village.

3.4.2 Historic/Cultural/Archaeological Sites

Historic properties in Grand Canyon National Park listed on the National Register of Historic Places consist primarily of buildings associated with tourism, park administration and operations, and mining enterprises. In total, 485 buildings are included in the park's list of classified structures; 61 of these are archaeological sites with standing walls.[9]

Four historic districts and two historic buildings on the South Rim are listed on the National Register of Historic Places. These and other eligible properties are identified in the 1995 GCNP General Management Plan/Environmental Impact Statement. Eligible properties receive the same protection as listed properties (in the National Register) under the National Historic Preservation Act. The Grand Canyon Village Historic District includes some 238 buildings, four of which have been designated as National Historic Landmarks - El Trovar Hotel, the Grand Canyon park operations building, the Grand Canyon powerhouse, and the Grand Canyon railroad station. The Mary Jane Colter Historic District (also designated a national historic landmark) consists of four buildings - Hopi House, Lookout Studio (both of which are also in the Grand Canyon Village Historic District), Hermits Rest, and Desert View Watchtower. The Grandview Mine and Orphan Mine historic districts, the latter having been determined eligible for listing in 1994, are representative examples of mining operations in the park. Two other national

register properties are located on the South Rim - the water reclamation plant and the Tusayan Ruins.[10]

Three historic districts on the North Rim are listed in the National Register of Historic Places. These include the Grand Canyon Inn (North Rim Inn) and Campground District, the Grand Canyon North Rim Headquarters Historic District, and the Grand Canyon Lodge Historic District, the latter a designated National Historic Landmark.[11]

Other historical districts in the park include the Cross Canyon Corridor District and the Trans-Canyon Telephone Line District. The Cross Canyon Corridor historic district includes 44 buildings and structures and the Bright Angel, South Kaibab, North Kaibab and connecting river trails. Among the principal structures in the district are four trailside rock shelters and the Phantom Ranch complex, including the five original stone buildings designed by Mary Jane Colter for the Fred Harvey Company along Bright Angel Creek at the bottom of the Grand Canyon in 1922.[12]

The trans-canyon telephone line is approximately 18 miles long and roughly parallels the Bright Angel and North Kaibab Trails from the South Rim to Roaring Springs, with a spur line running two miles up the South Kaibab Trail. The line consists of 592 metal poles strung with copperweld wire. The poles, installed in 1935 and modified in 1938-39 to provide the national park with its own telephone system, retain their original appearance. Although two small sections of the line have been removed in recent years, the line possesses a high degree of integrity.[13]

Archaeological resources are also prevalent. The earliest suggestion of human use of the Grand Canyon is a Folsom projectile point discovered in the Marble Canyon area, which may have been left there as early as 10,500 years ago. Consistent, well-documented evidence of human use of Grand Canyon appears in the form of small figures made of split-willow twigs that represent game animals and date to about 2,500 B.C. Habitation levels of the canyon appear to have been relatively stable until around 500 A.D., when small groups of basketmakers began living in modest villages of circular pit-houses with mud and brush roofs, and using a distinctive gray pottery. The population of the canyon then began to grow considerably. The population increased dramatically by 1100 A.D.; of the more than 2,700 archaeological sites known within the park, 70 percent were occupied between 1050 A.D. and 1150 A.D. [14]

Only a small portion of the park has been formally surveyed for archaeological sites, but more than 2,700 have been recorded. The river corridor, the southern extension of the Walhalla Plateau on the North Rim (known as Walhalla Glades), portions of the Grand Canyon Village, the trans-canyon corridor, and portions of East Rim Drive have been systematically surveyed for archaeological resources; these are all areas that receive heavy visitation and disturbance by modern visitors. The remainder of the canyon has not been thoroughly inventoried. Archaeologists estimate there may be as many as 61,000 sites in the park. The density of sites in surveyed areas averages one site in 20 acres and ranges from one site for every seven acres in the vicinity of the Grand Canyon Village to one site in 349 acres on Swamp Ridge. The estimated density for the North Rim is one site in every 14 acres and one site in every 31 acres on the South Rim.[15]

Site density on the South Rim is high, with archaeological materials nearly continuous from Buggeln Hill (east of the Kaibab monocline) to Desert View. In addition to the prehistoric materials, the area contains remains suggesting limited and continuous use into historic times. The area near the Hance trailhead is known to be sacred to the Havasupai.[16]

The North Rim has some of the most important archaeological sites in the park, especially in the Walhalla Glades area. The expansion and exploitation of the North Rim by ancestral Puebloan peoples is evidenced by the extensive remains found on the North Rim, particularly in Walhalla Glades. Intensive surveys of this 4,000-acre area have located hundreds of sites. There are only three known archaeological sites near Bright Angel Point, but none within the existing development area. One small masonry structure lies near the Rim Transept trail and is currently interpreted to the public.[17]

There are a large number of archaeological remains in the Tuweep area; the entire Esplanade consists of a dispersed scatter. Three recorded sites are within the campground and are sustaining ongoing impacts from visitor use.[18] The corridor trails were used prehistorically and pass near many archaeological sites of varying size and importance. The trails have been surveyed for archaeological resources, but subsequent checks have indicated that the existing data are of poor quality. Archaeological sites near trails often receive some of the greatest impacts from erosion and illicit collection. Human burials associated with ancestral Puebloan occupation have been found at an archaeological site near Cottonwood Camp on the North Kaibab Trail.[19]

Phantom Ranch contains one well-studied pueblo and a number of features associated with it. Human burials have been found nearby. Besides having considerable evidence of Puebloan use, Indian Garden was the home of several Havasupai families until well into the 20th century.[20]

According to the 1986 NPS Aircraft Management Plan Environmental Assessment (AMP EA) for GCNP, an Anasazi cliff ruin near Point Sublime is the only archaeological site in the park which experienced significant nearby aircraft activity.[21] A study (Brumbaugh 1986) of the effects of helicopter vibrations on the Point Sublime site concluded that tour helicopters of the type and number then in use would not damage the ruins in the short-term and that no modifications were necessary to the approach patterns in use and minimum distances of tour helicopters from this site (approximately 300 feet). The study analyzed the short-term vibrational effects of ground velocity/acceleration and resonant shaking of the walls, but did not address potential long-term effects due to fatigue of the walls.

Since the Point Sublime site was the archaeological resource most visited by aircraft in the park, and was considered typical of most other potentially impacted sites, the AMP EA considered it reasonable to conclude that aircraft vibration impacts were not a short-term concern to the archaeological resources of the park. The AMP EA recommended further research before drawing conclusions concerning long-term impacts. Nonetheless, the AMP EA concluded that the Point Sublime archaeological site was the only site in the park where long-term impacts from aircraft activity were considered possible. In the

final rule Point Sublime was included in the Toroweap FFZ.

3.4.3 Wild and Scenic River Segments

GCNP also includes 277 miles of the Colorado River (108 miles of which are shared with the Hualapai tribe), one of the longest and most challenging recreational whitewater rivers in the world, with 160 recognized rapids. The NPS reports that the Colorado River within the GCNP meets the criteria but has not been designated as part of the national wild and scenic rivers system.[22] The NPS is required by its Management Policies (1988), consistent with applicable legislation, to manage its lands which meet the criteria for this designation the same as if they were so designated. This is to preserve the resources pending Congressional action.

3.5 NATURAL RESOURCES

In addition to geologic resources previously described, the Grand Canyon region is one of the most ecologically diverse in North America. Plant communities vary from cool, moist, subalpine forests and meadows between 8,000 and 9,000 feet elevation, to those of the hot, dry Great Basin, Sonoran, and Mojave Deserts at elevations as low as 1,200 feet. Grand Canyon vegetation is primarily controlled climatically, "with precipitation, maximum summer temperatures, and minimum winter temperatures interacting to distribute plants into more or less discrete elevational zones."[23] As described in Section 2.2, GCNP is a World Heritage Site.

3.5.1 Wilderness and Wildlife Resources

Over onemillion acres in the park meet the criteria for wilderness designation as part of the National Wilderness Preservation System. If combined with over 400,000 additional acres of proposed or designated wilderness contiguous to the park boundary, this area could become one of the largest, primarily desert wilderness areas in the United States.[24] The NPS is required by its Management Policies (1988), consistent with applicable legislation, to manage its lands which meet the criteria for this designation the same as if they were so designated. This is to preserve the resources pending Congressional action.

Saddle Mountain Wilderness Area is located west of Marble Canyon and is managed by the U.S. Forest Service. Under the final rule, Saddle Mountain was included in the Bright Angel Flight Free Zone.

Arizona Strip Wilderness Area is located in the Kaibab Plateau and is managed by BLM. Arizona Strip has no air tour activity and under the final rule Fossil Corridor was closed.

Because of the diverse geologic, ecologic, and climatic conditions within the park, there are about 1,500 plant species, 290 bird species, 90 species of mammals, 60 reptile and amphibian species, and 25 species of fish. This includes 3 plant and 7 animal species listed as endangered on the U.S. List of Endangered and Threatened Species (see Table 3.1).[25] Only two of the endangered species are not-ground living. The endangered species most likely to potentially be affected by the proposed SFAR modifications would be the avian species, specifically the American peregrine falcon. The California condor was released December 12, 1996 by Fish and Wildlife Service at Vermillion Cliffs to the west of Marble Canyon and 30 miles north of the GCNP. Vermilliion Cliffs has no air tour

activity and is outside the study area. . Section 4.9 discusses the potential for impacts to these endangered species.

3.5.2 Noise Environment

Ambient noise has been described as the continuous background sound environment (such as waves breaking on the shore, or a distant waterfall, or absolute silence in the absence of any wind or sounds from other sources). The ambient environment establishes the quieter moments in a setting and can mask intermittent sources (such as aircraft under some conditions). However, even in loud ambient settings, such as near waterfalls, distant sounds such as aircraft can sometimes be clearly audible.

The range in ambient sound levels, even from indigenous sources, can vary considerably from one location to another, or time to time at any given location. At one end of the spectrum is the sound level at the base of a powerful waterfall. At the other end of the spectrum is the near absence of any perceptible sound at all. These latter conditions may be found in areas devoid of flora or fauna. In the middle is an array of sound conditions which vary from moment to moment, hour to hour. During non-inclement weather conditions, these variations result from three factors in natural environments:

- Wind (its interaction with foliage, irregular terrain, or the human ear)
- Water (movement in streams, falls, or wave action)
- Animal (near continuous, such as insect; or intermittent, such as birds, coyotes, etc.)

The NPS measured ambient sound levels during the summer and fall of 1992. The range of ambient sound levels measured for select areas of GCNP is shown in Table 3.2. The ambient sound levels are shown in Figure 3-2.

"Natural quiet" is a resource found in GCNP and which, under the NPS Organic Act, as amended, is to be protected.[26]

3.6 POPULATION AND GROWTH CHARACTERISTICS

FAA Order 1050.1D requires that the affected environment section of an environmental assessment "identify, as appropriate, population and growth characteristics of the affected area...."[27] In the context of the proposed action, the appropriate demography to consider includes visitors to the GCNP and residents of affected communities, including Native Americans. Therefore, the following sections describe the expectations of GCNP visitors and, where data is available, indicators of visitor activity. Native American and other local communities are also discussed.

3.6.1 National Park Visitors

Understanding visitor expectations and the nature of visitor activity at GCNP is important in assessing aircraft noise impacts. The following discussion attempts to enhance the understanding of visitor types and park areas where restoring natural quiet is of greatest concern, keeping in mind the overall goal of substantial restoration of natural quiet.

Surveyed Visitor Expectations

The NPS surveyed GCNP visitors to rank the various reasons for their visit to the park. The results indicate the expectations visitors

have for their experience at the park. The ability of the park to fulfill these expectations is considered by NPS as an important factor in visitor satisfaction, the success of the park, and the ability to meet mission requirements.

Throughout the National Park System, approximately 90 percent of visitors rated "enjoy[ing] the natural quiet and sound of nature" as moderately to extremely important. At GCNP, 90 to 95 percent of responses from a mail survey gave natural quiet a similar rating. Visitor type affected response rates substantially, especially among visitors rating natural quiet as "extremely important." Table 3.3 summarizes the approximate value placed on natural quiet by different visitor types at GCNP.[28] It should be noted that the FAA has concern relative to the subjectivity of visitor survey data for the purposes of measuring aircraft noise impacts.

Table 3.3

Visitors to GCNP Rating Natural Quiet as Extremely Important

Visitor Type	Rating (approx. %)
Frontcountry	35%
Summer Backcountry	50%
Fall Backcountry	75%
River (Motor)	68%
River (oar)	88%

Source: National Park Service, Report to Congress, Figure 9-4.

Survey results also clearly report that there are many other moderately to extremely important reasons for visits to GCNP. Overall, over 85 percent of visitors report exercise, learning and family activity among the most important reasons.[29]

Visitor Activity

Table 3.4 shows recent activity levels by selected visitor types at GCNP. It is important to note that most classes of visitor activity at GCNP are limited or controlled in some way by the NPS to insure that there will be no derogation or impairment of resources and values.[30]

3.6.2 Native American Communities

Six Native American communities, represented by eight separate tribal governments, have ancestral ties to the Grand Canyon. The Colorado River, the canyon, the larger landscape in which they occur, and many of the park resources are considered sacred by many within these Native American communities. Within this larger landscape are sites, locations, and resources that are of traditional significance to all tribes in some cases, and to only some tribes in others. These Native American traditional cultural properties are tangible historic properties potentially eligible to the National Register of Historic Places because of their association with cultural practices and beliefs rooted in history and their importance in maintaining the cultural identity of ongoing Native American communities.

The following is a summary of each community's spiritual and traditional interests in the canyon.[31]

Havasupai

The Havasupai Reservation lies within and on both rims of Cataract (Havasu) Canyon and is bordered by the Hualapai Indian Reservation to the west, Kaibab National Forest to the east, the GCNP to the north and private sector lands to the south. The

Havasu River essentially divides the reservation as it flows toward the Colorado River. Havasupai ancestral lands covered an area from the Colorado River on the north to the Bill Williams Mountains and the San Francisco Peaks on the south, the Aubrey Cliffs on the west and the Little Colorado River gorge to the east. The area between the mouth of the Little Colorado river and the mouth of the Mohawk Canyon is the historical foundation of the Havasupai people. Limited archaeological evidence suggests use of this area dates back to 700 A.D., although the majority of Havasupai remains within Grand Canyon date to after 1300 A.D..

Red Butte, located outside the park, is considered to be the birth place of the Havasupai. Hance Trail, in Grand Canyon National Park, has religious significance, as it is part of their migration route north from Red Butte into the Grand Canyon. The Havasupai are extremely reluctant to divulge the location of sacred sites.

Although they hunted and gathered wild plants throughout their territory on the rim and in the canyon, the Havasupai also farmed in Havasu Canyon, Indian Garden and Fossil Bay. Residences were located below Hermits Rest on the same plateau as Indian Garden and as far east as Desert View, where a Havasupai family lived below the present watchtower. The FAA, has consulted with the tribe and in coordination with the NPS, will continue to seek ways to protect the privacy of the tribe.

Hualapai

The Hualapai (People of the Tall Pines) Tribe has a long history in the Grand Canyon. Their reservation borders 108 miles of the river, although their ancestral interests are much broader. Hualapai tradition places their ancestral boundary at the Colorado River on the north and west, the San Francisco Peaks on the east, and the Bill Williams and Santa Maria rivers on the south.

The Colorado River is a significant landmark for the Hualapai, both physically and spiritually. The center of the Colorado River is the northern boundary of the Hualapai reservation. The Hualapai have occupied and used the lands and water lying within their aboriginal territory, as well as within the present reservation for more than a thousand years.

Hopi

The Hopi Reservation lies within the Navajo Reservation and is divided by the Dinnebito Wash and Polacca Wash as they drain toward the Little Colorado River. According to Hopi tradition, the Hopi people began with their emergence into the present world through the *Sipapu*, a travertine cone in the Little Colorado River gorge outside the boundaries of the park. From that place, they spread throughout the southwestern United States.

The migrations of some of the clans included residence in the Grand Canyon. Archaeological investigations substantiate these claims, indicating they have used the canyon since about 700 A.D..

Hopi people continue to use the Grand Canyon for important ceremonial and ritual purposes. Some of their most sacred sites are inside and immediately adjacent to the park, such as the Hopi Salt Mines on the Colorado River inside the park.

Hopi Salt Mine is located Northeast of the Desert View Flight Free Zone one and is

outside the SFAR in the Final Rule establishing Subpart U. With the exception of normal egress and ingress to the airport, which does not affect Hopi Salt Mine, all air tour traffic is in the SFAR in the Final Rule establishing Subpart U.

Navajo

The Navajo Reservation borders Grand Canyon National Park from Lee's Ferry to the confluence of the Little Colorado River. The Navajo tribal government is divided into local governances called chapters. The Cameron and Gap-Bodaway chapters border Grand Canyon National Park.

Archaeological and linguistic evidence suggest that the Athapaskan-speaking ancestors of the people now known as the Navajo migrated into the American Southwest sometime between about 1000 A.D. and 1500 A.D.. They spread into the area to the east of the Colorado River and north of the Little Colorado during the 19th century.

The Navajo view the Colorado River and the Little Colorado as sacred beings.

Southern Paiute (Kaibab, Shivwits, and San Juan Paiute Tribes of Utah)

While the Kaibab, Shivwits, and San Juan Southern Paiutes are three separate tribes, their beliefs, ties to the Grand Canyon, and concerns are similar. Therefore, they will be discussed as one people, the Southern Paiute. The NPS General Management Plan for the GCNP indicates that the Southern Paiute are located within the Navajo reservations although there is no specific reservation designation shown on standard location maps. Additionally, the Kaibab Reservation (considered Southern Paiute by the General Management Plan for the GCNP) is located on the northern border of Arizona and is approximately 23 miles at its closest point to the GCNP.

Archaeological evidence of Southern Paiute use of the area may be found dating as early as A.D. 1150. The traditional boundary for the Southern Paiute within Grand Canyon extended from the junction of the Paria and Colorado rivers downstream to Kanab Creek.

Zuni

The Zuni, while not residents of the affected environment, have ancestral ties to the Grand Canyon. The traditional area of Zuni land use is bounded by the San Francisco Peaks and portions of the Little Colorado River on the north. Archaeological sites, traditional cultural properties, and other sacred locations along the Colorado River corridor and the Little Colorado River are important to Zuni traditional and cultural values, providing important spiritual linkages to the place of emergence for the Zuni Tribe.

3.6.3 Local Communities[32]

Several communities are located near GCNP, with the largest near the South Rim. These communities are dependent upon GCNP due to the tourist activity and employment generated by GCNP. GCNP depends upon these communities for traveler facilities that do not exist at the park and for yearly and seasonal employees. The communities with most immediate relevance to GCNP and this study are discussed briefly below.

The South Rim communities are Grand Canyon Village, Tusayan, and Valle. These three communities are located on Arizona 64/U.S. 180. These communities are service

areas for the majority of park visitors; they also function as residential areas for households of NPS and private service business employees. The economies of all three communities are oriented to serving park visitors.

Grand Canyon Village provides housing for NPS and concessionaire employees and their families. The village's population was reported to be 1,499 at the time of the 1990 census. During mid-summers the addition of seasonal workers increases the village's population to about 2,100. The state of Arizona projects the year-round population of Grand Canyon Village to be 1,950 in 2010 (Arizona Department of Economic Security 1993a). Based on the current ratios for permanent-to-seasonal workers, the peak summertime population is projected to be 2,730 in 2010.

Tusayan is an unincorporated community three miles from the park's south entrance. The 1990 population of Tusayan was 555. Tusayan's population is estimated to increase to about 1,000 during the peak of the tourist season. The state of Arizona projects the year-round population of Tusayan will be 1,000 in 2010 (Arizona Department of Economic Security 1993a). Based on the current ratios for permanent-to-seasonal workers, the peak summertime population would be 1,800 in 2010. Tusayan's business district is almost exclusively oriented to serving tourists going to and from the park.

Grand Canyon National Park Airport (see Figure 3-1), south of Tusayan is the third busiest in Arizona, with 535,000 deplanements in 1993. Long-range plans are to expand the airport in anticipation of continued growth in air travel. Commercial helicopter flights over the Grand Canyon are staged out of the airport area. Some helicopter air tour services also fly out of the Tusayan townsite.

Valle is a small unincorporated community at the junction of Arizona 64 and 180. The 1990 census reported its population to be 123; its population increases during the tourist season. No population projections are available.

Communities outside the east entrance to the park include Page, Tuba City, Cameron, and Gray Mountain. U.S. 89 links these communities and is traveled by tourists visiting either the park's North or South Rim.

Much of the East Rim area is on the Navajo Reservation. Tuba City and Cameron are on the reservation, and Page and Gray Mountain are adjacent to it.

The Colorado River and the Grand Canyon serve as barriers that isolate North Rim communities from the more populated areas of Coconino County. The North Rim communities include the developed North Rim area within Grand Canyon National Park (including Bright Angel Point), Jacob Lake, Fredonia, Kanab, and Marble Canyon. Visitors to the North Rim travel U.S. Alternate Route 89 east through Fredonia or west through Marble Canyon to Jacob Lake. From Jacob Lake, Arizona 67 provides a direct route to the park's North Rim.

3.7 RELATIONSHIP OF PROPOSED ACTION TO NATIONAL PARK SERVICE GOALS FOR GCNP

In its September 1994 report to Congress, the NPS reviewed its mandates, regulations, policies, and plans related to the protection of natural quiet and the provision of various visitor experience opportunities. From this review, a statement of management goals

and objectives was developed to further assist the NPS in its evaluation of the effectiveness of limitations on aircraft operations in the GCNP and the vicinity. This statement describes the goals and then summarizes the specific management objectives for GCNP.[33]

NPS goals for aircraft overflight management are:

1. Substantially restore natural quiet as a natural resource.
2. Provide recreation opportunities and experiences for park visitors, consistent with park policies, where the opportunity for natural quiet is an important component.
3. Mitigate any aircraft-related impacts on other natural and cultural resources.
4. Address issues of health, safety and welfare of on-ground visitors and employees.
5. Restore and maintain natural quiet by protecting the wilderness character of remote areas.
6. Provide primitive recreation opportunities without aircraft intrusions in most backcountry areas, most locations on the river and at destination points accessed by both.
7. Provide developed recreation opportunities with limited aircraft intrusions for visitors at rim developed areas and major frontcountry destination points.
8. Provide for protection of sensitive wildlife habitat areas and cultural resources.
9. Provide for welfare and safety of below-rim, backcountry, and rim visitors.
10. Provide a quality aerial viewing experience while protecting park resources (including natural quiet) and minimizing conflicts with other park visitors.

The proposed new action would advance many of these NPS goals without derogating any. It will provide an incentive for the use of quieter aircraft within the GCNP, establish additional limitations to further reduce the impact of aircraft noise(phaseout). In addition, a comprehensive noise management plan will be jointly developed to provide a long term solution that will maximize the gains in noise reduction and substantial restoration of natural quiet attributed to the phaseout. The overall reduction in noise resulting from the proposed action would further the NPS goal of restoring natural quiet in the GCNP and minimizing noise in adjacent areas.

1 National Park Service General Management Plan DEIS, pg.155; Note that a GMP Final EIS was completed and a Record of Decision (ROD) issued in August 1995.

2 National Park Service General Management Plan DEIS, pg. 157

3 National Park Service General Management Plan DEIS, Management Zones map, pg. 15

4 National Park Service General Management Plan DEIS, pg. 4 and 161

5 National Park Service General Management Plan DEIS, pg. 4

6 National Park Service General Management Plan DEIS, pg. 48

7 National Park Service General Management Plan DEIS, pg. 6

8 National Park Service General Management Plan DEIS, pg. 154

9 National Park Service General Management Plan DEIS, pg. 146

10 National Park Service General Management Plan DEIS, pg. 146

11 National Park Service General Management Plan DEIS, pg. 148

12 National Park Service General Management Plan DEIS, pg. 148

13 National Park Service General Management Plan DEIS, pg. 148

14 National Park Service General Management Plan DEIS, pg. 140

15 National Park Service General Management Plan DEIS, pg. 140

16 National Park Service General Management Plan DEIS, pg. 141

17 National Park Service General Management Plan DEIS, pg. 141

18 National Park Service General Management Plan DEIS, pg. 141

19 National Park Service General Management Plan DEIS, pg. 141

20 National Park Service General Management Plan DEIS, pg. 141

21 National Park Service, Aircraft Management Plan Environmental Assessment, May 1986, page 16

22 National Park Service General Management Plan DEIS, pg. 4

23 Phillips et al, 1987.

24 National Park Service General Management Plan DEIS, pg. 4

25 USDOI Fish and Wildlife Service Arizon Ecological Services Field Office letter, dated November 13, 1996, and National Park Service General Management Plan DEIS, pg. 135

26 NPS Report to Congress, pg. 44

27 FAA Order 1050.1D, par. 65(b)

28 National Park Service Report To Congress, Figure 9-4, pg. 191

29 National Park Service Report To Congress, Figure 9-3, pg. 190

30 National Park Service Report To Congress, pg. 175

31 National Park Service General Management Plan, pgs. 141-145

32 National Park Service General Management Plan, pgs. 157-158

33 National Park Service Report To Congress, pg. 184

CHAPTER FOUR ENVIRONMENTAL CONSEQUENCES

This chapter reports on the analysis conducted to determine the environmental impacts of the existing condition and the alternative under consideration. The primary goal of the alternative is to improve the aircraft noise environment in the Grand Canyon National Park (GCNP) and the surrounding area, hereafter referred to as the GCNP study area. The chapter summarizes the unique conditions underlying this analysis. The environmental factors considered are those contained in FAA Orders 1050.1D. The primary consideration is noise. The analysis presented here indicates that, within the analysis area as shown in Figure 1-1 (see Chapter 1), the noise environment as a whole is improved by the proposed action. The analysis also demonstrates that restoration of natural quiet can be fully achieved with the proposed action. At certain representative locations, predicted noise levels increase with the proposed action but for the majority of locations, a decrease is observed.

4.1 NOISE

An aircraft noise modeling effort was conducted to predict sound levels from aircraft activity in the vicinity of the Grand Canyon National Park (GCNP). The purpose was to compare a No Action and a Proposed Action alternative to determine whether any significant adverse effects could be expected, as well as to disclose any benefit that would result from the federal action.

The noise analysis was conducted by the Federal Aviation Administration (FAA) Office of Environment and Energy (AEE), in conjunction with the Volpe National Transportation Systems Center (Volpe Center). Both the FAA and The National Park Service (NPS) provided data used in the modeling process. The analysis estimates aircraft sound levels by providing values of equivalent A-weighted sound levels, for a specified time period, T (L_{AeqT}) and percentage of time, T, within which aircraft are audible (%TA_T). For definition of L_{AeqT} and %TA_T, refer to Appendix D, Glossary. In addition, these noise metrics are described in more detail below.

Because of the unique physical and natural environment at the GCNP, unusual technical considerations were associated with this modeling task. The following sections address the technical issues, discuss the modeling assumptions used in the analysis, and compare the findings and results for the two alternatives.

4.1.1 NOISE CRITERIA

Traditionally, analysis of aircraft noise has focused on communities in the vicinity of airports and military installations, or under military aircraft training airspace. In these situations, minimizing interference with human activities such as conversation, listening to radio or television and prevention of adverse health effects has been the goal. The proposed action under consideration in this EA addresses the reduction of aircraft noise in a unique Park environment. Specifically, the analysis seeks to: (1) determine whether the proposed action will result in any significant noise impacts, either within or outside of the GCNP; and (2) determine the effectiveness of the proposed action in providing substantial restoration of natural quiet to the GCNP.

Two separate criteria were needed to judge the effects of the rule on sound levels. For the entire study area, significant noise impacts are based on FAR Part 150, Appendix A, Table 1, supplemented by an evaluation of increases at representative locations. Namely, significant noise impacts occur if the Day-Night Average Sound Level (DNL, represented by the symbol L_{dn}) of 65 dB is exceeded anywhere after the proposed action, but not before. This criterion of L_{dn} 65 dB will be examined in terms of an equivalent A-weighted sound level for the 12 hour period during which tour aircraft fly, L_{Aeq12h}. The L_{dn} criterion translates to L_{Aeq12h} = 68 dB, (see Appendix E: Noise Basics). Contours of L_{Aeq12h} and computations of levels at representative locations are used to judge this type of noise impact, as defined by FAR Part 150.

The second criteria examines progress toward restoring natural quiet. In the Report to Congress, for aircraft overflights, the NPS defined "substantial restoration of natural quiet" in the Grand Canyon in the following quantitative way:

> "...substantial restoration requires that 50% or more of the Park achieve 'natural quiet' (i.e., no aircraft audible) for 75 - 100 percent of the day." [RTC p 182]

This definition establishes several requirements for the criterion used to judge restoration of natural quiet. First, the criterion must consider aircraft-produced sound in terms of audibility. Second, audibility of aircraft must be examined for the entire area of the Park. Third, audibility of aircraft needs to be examined throughout the day. With these considerations, the criterion for judging progress toward substantial restoration is described as follows:

> Substantial restoration of natural quiet occurs when tour aircraft are audible for less than 25% of the day in more than half of the Park area. Hence, to meet the NPS definition of substantial restoration, the total area of the Grand Canyon that experiences audible aircraft for more than 25% of the day must be less than half (50%) of the Park.

Because the impact of aircraft sound is the loss of natural quiet within the GCNP boundary, progress toward substantial restoration of natural quiet (increasing areas experiencing natural quiet) is an important indicator of no significant noise impacts. The NPS has recognized that though sound levels may increase in some areas of the Park, no significant impacts will be judged to occur provided progress is made toward substantial restoration.

Technical Considerations

Important technical considerations for the GCNP analysis include the elevation of the listener. For a given aircraft overflight altitude, the sound level experienced at the Canyon rim will be higher than the level experienced by a hiker several thousand feet lower on a trail. Factors such as terrain, meteorological conditions, and natural and vegetative characteristics are increasingly likely to alter the propagation and characteristics of aircraft sound as the distance from the aircraft increases. Also, the amount of sound absorbed or reflected by the ground can alter the sound levels heard.

The modeling of the tour aircraft sound

levels was conducted by AEE in conjunction with Volpe Center. The following section describes the computer model used and the reasons for its use.

Integrated Noise Model

Traditionally, for analysis of noise impacts on lands where people live, the criteria for impacts are based on minimizing interference with human activities such as conversation, listening to radio or television, and on prevention of adverse health effects. Computer models have been designed to compute metrics selected to relate to these effects, namely L_{dn} or similar equivalent metrics. In the Park environment, however, where preservation or restoration of natural quiet is the objective, simply hearing aircraft-produced sound may be considered an impact. Hence, the computer model needs to provide a metric that quantifies how much of the time aircraft can be heard.

The Integrated Noise Model (INM) is the FAA's standard computer methodology for assessing and predicting aircraft noise impacts. Its use in regulatory actions is governed by FAA Order 1050.1D, "Policies and Procedures for Considering Environmental Impacts" under the National Environmental Policy Act (NEPA). Since 1978, the INM has been widely used by the aviation community both nationally and internationally to evaluate noise impacts from new airports, runways, arrival and departure routes, flight procedures, and fleet forecasts. The FAA has continuously refined and updated the INM's system capabilities, aircraft noise and performance data, and computer technology, most recently with the release of INM Version 5.0. The INM noise calculation methodology and aircraft noise and performance database meet the standards of the Society of Automotive Engineers' (SAE), Aerospace Information Report (AIR) 1845, "Procedure for the Calculation of Airplane Noise in the Vicinity of Airports", March 1986 and the International Civil Aviation Organization (ICAO) Circular 205-AN/1/25, "Recommended Method for Computing Noise Contours Around Airports", 1988.

The FAA chose to use INM in conducting this analysis because of (1) its widespread scientific acceptance; (2) its use of methodology that conforms to industry and international standards; (3) its measurement-derived noise and performance data; (4) its ability to calculate noise exposure over varying terrain elevation; and (5) its adaptability and reliability for assessing a variety of situations, including Grand Canyon noise impacts. On the basis of the above, the FAA determined that a modified version of INM 5.0 is an appropriate tool to use for this analysis. Specific modifications made to Version 5.0 for use in modeling GCNP noise are as follows:

Expanded Terrain Analysis

Beginning with Version 4.11 in 1993, the INM was capable of taking into account the effects of varying terrain elevation on slant distance from the aircraft to a receptor on the ground. However, since INM is intended for analyses in the immediate vicinity of an airport, terrain analyses were limited to a 1-degree latitude by 1-degree longitude area of approximately 2300 square statute miles, with the airport placed at its physical center. For current GCNP analyses the area was expanded to 4-degrees latitude by 2-degrees longitude. Consequently, changing slant distance from aircraft to receptor is considered for the entire GCNP analysis area.

Expanded Receptor Grid for Contour Analyses

Since its inception, the INM has based noise level contour computations on a fixed, regularly-spaced grid of 289 receptors (17-by-17). The 289 receptors, along with information about aircraft flights and flight proximities to a receptor, are used to guide the process of subdividing the base noise-grid in an effort to improve noise-contour precision. For most airport analyses, a distance of 6250 ft (approximately one nautical mile) is maintained between receptor locations in the base grid. Maintaining this spacing is essential in ensuring accuracy in the decision-making process associated with subdividing the noise grid. As a consequence, the 17-by-17 point grid of receptors in the base regular grid was expanded to 125-by-125 points for GCNP analyses. This expansion ensured that the 6250 ft spacing associated with most typical INM-related analyses was maintained throughout the entire GCNP analysis area.

Percent Time Audible and Ambient Noise Levels

The National Park Service (NPS) has adopted the percent time audible descriptor for assessing noise in GCNP. It is defined as the percentage of time aircraft noise can be detected by a human observer at a receptor location during the time period in which GCNP is open to visitors. In fact, the NPS criterion for natural quiet is based on this descriptor. To allow for comparisons with NPS analyses, the time-above descriptor in INM was modified.

Rather than the INM user providing a noise level threshold above which time-above is computed, the INM was modified to read a NPS-developed file containing ambient sound levels for all areas encompassed by the GCNP boundary. A 3 dB aircraft detectability criterion was then factored into the computation, and the total time aircraft could be heard at a receptor location was computed.

The 3 dB detectability criterion is commonly accepted in the acoustics community as the smallest change in sound level perceptible to the human ear. In other words, given an ambient A-weighted sound level of 40 dB, the introduction of aircraft into the ambient environment would have to result in at least a 43 dB sound level (a 3 dB increase) for the human ear to be able to discern the aircraft.

Audibility of aircraft depends upon many factors such as the level and frequency spectra of the aircraft sounds, the level and frequency of ambient or non-aircraft sounds, and the attentiveness of the listener. Using INM A-weighted levels, the 3 dB criterion assumes that the frequency characteristics of the ambient and the aircraft are relatively similar.

The total time above the ambient (with the 3 dB detectability criterion factored in) was then converted to percent-time audible by dividing total time by the number of hours the Park was open to visitors. In the current analysis this divisor was always 12 hours. An assumption inherent in the time audible computations for this analysis is that operations do not overlap in time (i.e. user specified operations are modeled in a serial fashion).

The NPS ambient file was based on field measurements conducted in GCNP for seven acoustically unique categories of land. In developing the file, the NPS assigned parcels of land to one of seven categorical

designators in its model with associated ambient sound levels of 15.0 dB, 17.0 dB, 17.5 dB, 19.6 dB, 26.0 dB, 37.5 dB, and 50.0 dB. Ambient levels for the Grand Canyon were provided by the NPS and are depicted in Figure 4-1.

Introduction of Circuit Operations

A circuit operation is an activity in which an aircraft departs from a primary study airport, in this case GCNP, continues on in flight with an unlimited number of changing altitude/performance flight segments, and eventually returns to the study airport. The introduction of circuit operations in INM allows for the correct and expedited modeling of GCNP tours.

In previous versions of INM, a single tour operation was modeled separately as a departure and an approach. However, the process of doing this, although technically correct, was quite tedious because the transition from the departure to the approach segment had to be acoustically seamless. This required a significant amount of numerical manipulation to smoothly align the end of the departure segment with the start of the approach.

Suppression of Overground Attenuation Algorithm

Based on the FAA review of the technical considerations affecting this study, the FAA modified the INM to eliminate computation of lateral over-ground attenuation, which is oriented toward acoustically soft grassy terrain unlike that found at the Grand Canyon.

In determining the appropriateness of the above modifications for this analysis, FAA performed a check of reasonableness of INM predictions using data obtained from actual measurements in the Grand Canyon. This check, as presented in Appendix B, compared measured and INM-predicted sound exposure levels (SEL, denoted by the symbol L_{AE}) for individual flyover operations and L_{Aeq1h} values at GCNP. The results of this predicted INM data correlates closely with actual measured data in the Canyon.

As discussed above, sound metrics are needed that can be used to judge both restoration of natural quiet within the Park (reduction of audibility of aircraft), and noise impacts outside the Park in accordance with FAR Part 150 guidelines.

Restoration of Natural Quiet As mentioned above, INM was modified in the current analysis so that a measure of aircraft audibility could be obtained. In this analysis of the Grand Canyon, the objective is to identify areas where aircraft are audible for more than 25% of the day (loss of natural quiet), so that the metric of interest is the percent of a day for which aircraft are audible. The length of the day is the length of time that tour aircraft are likely to be flying. A 12 hour period representing the hours 7 a.m. to 7 p.m. was chosen.

The INM was used to compute areas of the Park where aircraft, using both average noise energy and time audible measures, could be heard for more than 25 percent of the time. Contours are used to show these areas and to permit evaluation of the area where this level of aircraft audibility occurs. The long-term objective is met when this area includes less than half the Park.

Noise Impacts Outside the Park The INM's primary computational methods are designed to analyze noise impacts as defined by FAR Part 150. Normally, the L_{dn} metric is used.

However, because L_{dn} is a measure of sound produced during a 24 hour period, and tour operations occur for 12 hours of the day, a metric similar to L_{dn} but applying to only 12 hours is computed - the equivalent A-weighted sound level for a 12 hour period, L_{Aeq12h}.

In this analysis, L_{Aeq12h} is interpreted by using the land-use compatibility guidelines of FAR Part 150 and by determining whether any areas outside the Park experience L_{Aeq12h} = 68 dB or greater after the rule but not before[1]. Such areas will experience an increase in aircraft-produced sound exposure to L_{dn} 65 dB or greater and should be considered as experiencing significant impact.

Other Noise Models

There are a number of aviation noise models in use for specialized purposes. Many of these models contain different assumptions and sound propagation algorithms.

Of relevance to this analysis is NPS development of a computer model designed specifically for analyzing audibility of aircraft in Park environments. The NPS has used this model, called the National Park Service Overflight Decision Support System (NODSS), in support of its evaluation of aircraft noise impacts at GCNP. NODSS uses different methodology than that accepted under FAA guidelines, including the calculation of audibility, a new non-standard metric. Unlike INM, audibility is calculated on a frequency basis (1/3 octave band) to account for the tonal nature of the source. The modified version of the INM time audible metric (Percent Time Above using a variable ambient and a 3 dB detectability factor) offers a viable comparison of modeled results with NPS noise predictions and noise criteria.

As part of the comprehensive noise management plan, the FAA and NPS will conduct a future evaluation of alternative noise assessment methodologies. A study program will be developed that includes the analysis of noise metrics and noise modeling systems. In addition, a noise measurement program at the GCNP will be undertaken to support the correlation of metrics, validation of models, collection of operations data and other verification initiatives.

4.1.2 MODELING ASSUMPTIONS

This section describes the comparative analysis of noise impacts between the No Action alternative and the Proposed Action (Phase-out of noisier aircraft and removal of the limit on the number of aircraft that may operate within the GCNP Study Area).

In order to compute sound levels, considerable information was used including selection of aircraft types, flight tracks flown (see Figure 4-2), and numbers of operations flown on each flight track. All input data for modeling both the No Action Alternative and the Proposed Action including aircraft noise, aircraft operations and aircraft performance are discussed below. Information for modeling the airspace that results from the proposed action was developed by FAA Air Traffic. The only change in airspace between the No Action and Proposed Alternative is the allowance for a return of aircraft that meet Category C quiet aircraft standards to the National Canyon Corridor (see Chapter 2 and Figure 4-2).

Aircraft

Figure 4-1

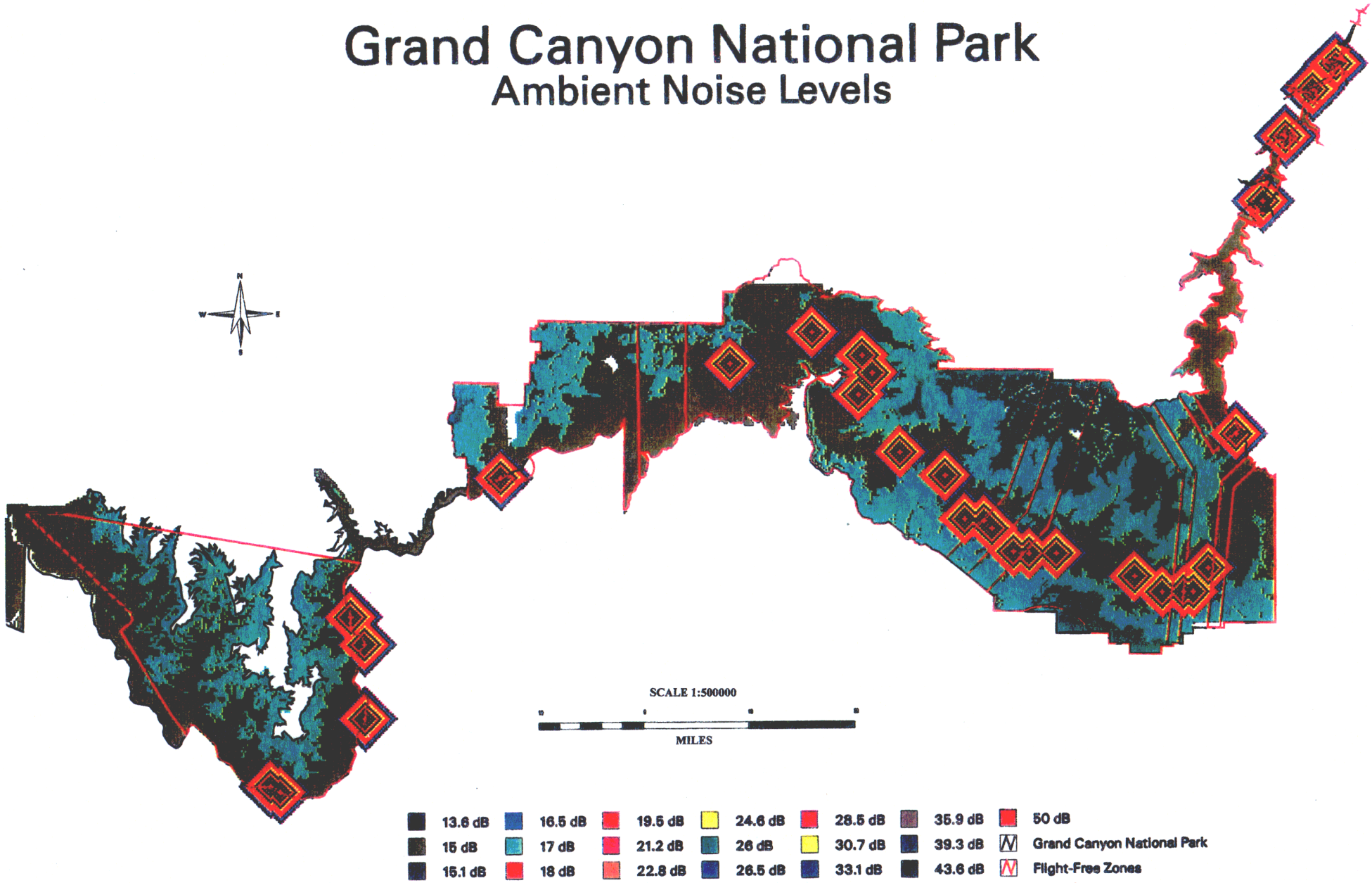
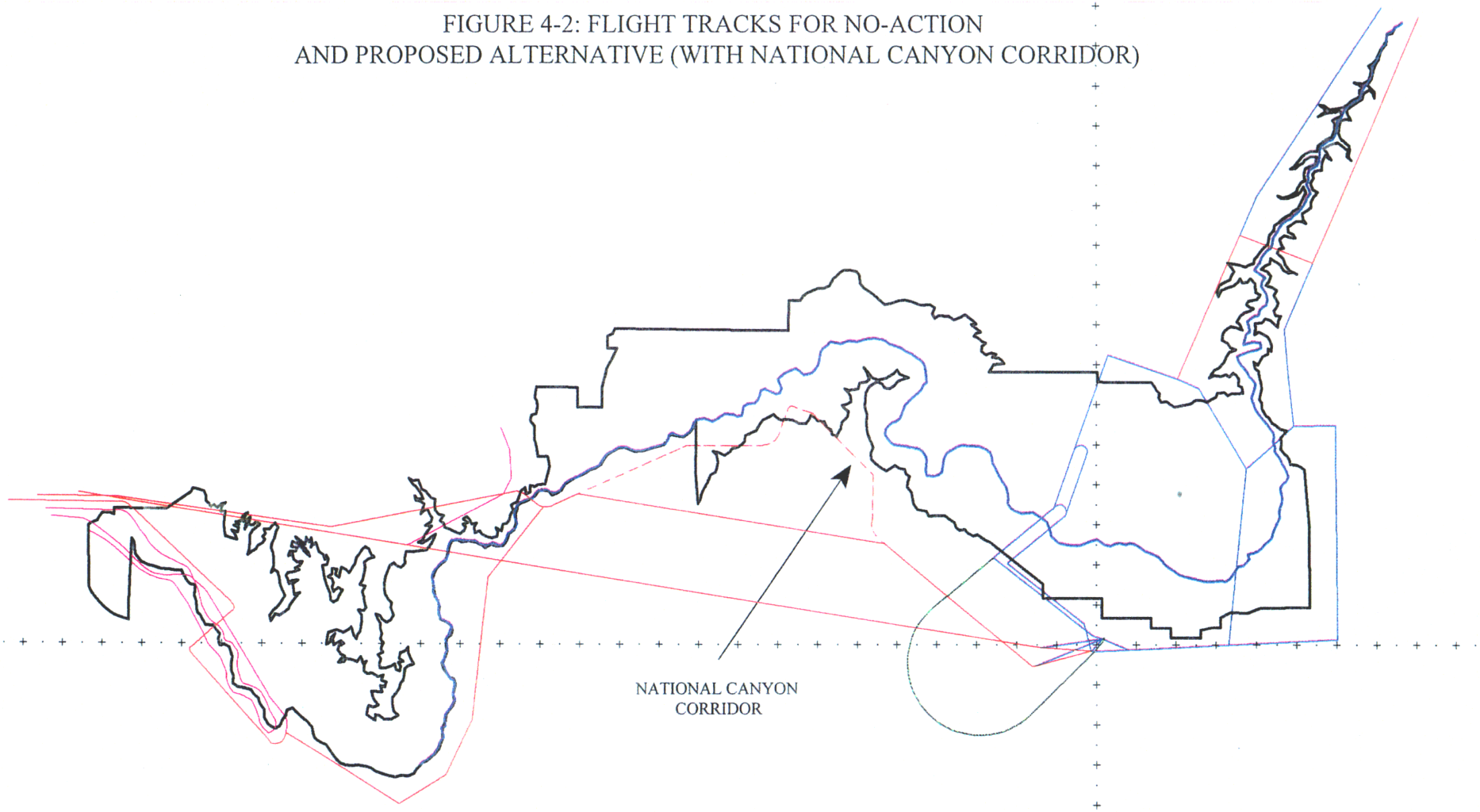

Grand Canyon National Park
Ambient Noise Levels
N
W
E
S
SCALE 1:500000
0
MILES
13.6 dB
15 dB
15.1 dB
16.5 dB
17 dB
18 dB
19.5 dB
21.2 dB
22.8 dB
24.6 dB
26 dB
26.5 dB
28.5 dB
30.7 dB
33.1 dB
35.9 dB
39.3 dB
43.6 dB
50 dB
Grand Canyon National Park
Flight-Free Zones

FIGURE 4-2: FLIGHT TRACKS FOR NO-ACTION
AND PROPOSED ALTERNATIVE (WITH NATIONAL CANYON CORRIDOR)



There are various types of aircraft operating in GCNP airspace, some of which are not included directly in the INM data base. In such instances, official INM equivalent aircraft were used for the current analysis. An INM equivalent aircraft is an aircraft which performs similarly and has similar Noise-Power-Distance (NPD) data as compared with another aircraft. Approved equivalents are included in the data base of the INM based on previously-conducted noise analyses. The specific INM-equivalent noise data, operational data, and INM-equivalent performance data are discussed separately in the following sections.

Noise Data

Table 4.1.2a presents the aircraft types which are currently flying in GCNP, their noise efficiency category, and the FAA-approved/INM-equivalent aircraft (in terms of NPD data). Noise efficiency categories are based on single event noise levels as a function of number of passenger seats. Aircraft in Category A are those which have relatively high noise levels per passenger seat, while those in category C have relatively low noise levels per passenger seat.

The McDonnell-Douglas MD900 helicopter is a relatively new, state-of -the-art helicopter, with minimal available noise data. The noise versus distance data used for INM predictions were empirically developed by the Volpe Center based on recommendations from McDonnell-Douglas Helicopter's Acoustics Group. The data were derived from FAA-certified noise levels for the craft.

Operational Data

The operational information, including number, type and distribution of aircraft was based on NPS analysis of FAA-supplied operational activity at GCNP for the 1995 calendar year. It is the most accurate, up-to-date operational information available.

Table 4.1.2b and Table 4.1.2c summarize the operational activity as a function of the type of operation, i.e., approach, departure, circuit, or overflight, for both the No Action and Proposed Alternative. In addition, the total average daily operations in 1996 were 544.1, which is based on a 3.3%, FAA projected growth rate applied to available 1995 operational levels.

The total average operations for 1997 were 514. This number was based on a ½ year's growth applied to 1995 levels, with an 11.3% reduction in operations on GCNP tour tracks to account for the effects of a summer curfew on such tracks. A late revision modified the effective date of the temporary cap from July 1996 to December 1996. This 6-month deferral represents a difference in the modeling analysis of approximately nine fewer annual operations for 1997. In future years, operations remain relatively constant since growth is applied (3.3 percent) to passenger seat capacity. The extent of this change is quite small and is expected to have a minimal impact on modeled noise levels.

In the case of the No Action Alternative, the 514 total operations were held constant for all future years. In the case of the proposed action, operations were held constant until 2000, and for subsequent years a moderate growth in operations was modeled such that by 2008, the total operations in the case of the proposed alternative was 565.6. The growth in total operations between 1997 and 2000 was relatively flat in the proposed alternative because smaller aircraft are replaced with larger aircraft and no increase in operations is needed to meet a

compounded annual growth rate of 3.3% in terms of passenger seats. The passenger seat growth rate is applied to the analysis beginning in 1998 when the proposed rule is expected to be implemented.

Profiles and Performance Data

In developing the airspace for the no action and the proposed alternative, FAA Air Traffic assigned altitudes to each unique flight track. In the case of both alternatives, these altitudes were considered target altitudes in the INM modeling process. Specifically, INM standard takeoff and approach procedures were assumed for all departure, approach and circuit operations at GCNP airport. Once aloft, changing-altitude flight profiles were developed using the INM profile generator, with the specific altitudes at the start and end of a flight-path segment as input. The generator was in-turn used to compute performance and position information for each segment, including distance from start of profile, altitude, speed and thrust. Similarly, performance and position information associated with level flight-track segments were also computed using the INM profile generator.[2]

Scope

The study area is defined by the smallest rectangle encompassing the entire GCNP boundary. The total area amounts to approximately 13,510 square statute miles, 145.5 statute miles east-to-west by 92.9 statue miles north-to-south. The Study area is portrayed in Figure 1-1.

Table 4.1.2a Categories of Aircraft Flying in GCNP

Current Tour Aircraft	Noise Efficiency Category	INM Equivalent Aircraft
Cessna 206 (Stationair) Cessna 402 (Businessliner) Beechcraft B76 (Duchess)	A	Beechcraft B58P (BEC58P)
Cessna 207 (TurboStationair) Beechcraft A36 (Bonanza) Cessna 180	A	General Aviation Single-Engine Variable-Pitch Propeller(GASEPV)**
Piper 31-325 (Navajo) Cessna R182 (Skylane) Beechcraft 99 (Baron)	B	Fixed Wing Quiet Noise Curve (CATBNC)***
Dehavilland DHC-6-300 (Vistaliner)	C	DeHavilland DHC-6-300 - 5 dB****
Cessna 208 (Caravan)	C	General Aviation Single-Engine Fixed-Pitch Propeller(GASEPF)*
Bell 206 L (Long Ranger) Bell 206L (Jet Ranger)	B	Bell 206L + 1.1 dB
Aerospatiale 350D (Astar)	B	A350D + 1.1 dB†
Aerospatiale 341 (Gazelle)	B	A341 + 1.5 dB††
McDonnell-Douglas MD900 NOTAR	C	MD900 + 1.3 - 3.6 dB†††
McDonnell-Douglas MD520 NOTAR	C	MD900 + 1.3 - 3.6 dB†††

* The general aviation, single-engine, fixed-pitch propeller aircraft (GASEPF) is a generic aircraft meant to represent a composite of all common, single-engine craft, with fixed-pitch propellers not specifically represented in the INM data base.

** The general aviation, single-engine, variable-pitch propeller aircraft (GASEPV) is a generic aircraft meant to represent a composite of all common, single-engine craft, with variable-pitch propellers not specifically represented in the INM data base.

*** The Fixed wing quiet noise curve is meant to represent a composite of all quieter single engine craft with variable-pitch propellers.

**** The 5 dB adjustment factor accounts for the Raisbeck/Hartzell "quiet" propeller system installed on these aircraft.

† The 1.1 dB adjustment factor corrects the INM noise level data from a speed of 116 kts (as currently in the data base) to a speed of 90 kts, which is considered typical for GCNP tour operations.

†† The 1.5 dB adjustment factor corrects the INM noise level data from a speed of 127.8 kts (as currently in the data base) to a speed of 90 kts.

††† The 1.3 dB adjustment factor corrects the INM noise level data from a speed of 121 kts (as currently in the data base) to a speed of 90 kts. The -3.6 dB adjustment factor was applied to the NPD data based upon preliminary data obtained as part of an on-going FAA noise measurement program which includes the MD900.

Table 4.1.2b: Summary of GCNP Operational Activities as a Function of Type of Operation, No Action Alternative

Type of Operation[1] (Annual Average Day)	Year
	1997, 2000, 2008
Approaches[2]	125.64
Departures[3]	128.41
Circuits[4]	167.59
Overflights[5]	92.33
Total	514.00

Table 4.1.2c: Summary of GCNP Operational Activities as a Function of Type of Operation, Proposed Alternative

Type of Operation[1] (Annual Average Day)	Year		
	1997	2000	2008
Approaches[2]	125.64	125.64	149.52
Departures[3]	128.41	128.41	152.81
Circuits[4]	167.59	167.59	164.23
Overflights[5]	92.33	92.33	98.99
Total	514.00	514.00	565.60

1 1.385 approach operations on the Blue Direct route from Las Vegas were erroneously assigned to departures on the same route. This has no measurable effect on the modeled results.

2 An approach is defined as an activity in which an aircraft that is in flight enters into the terminal airspace from an origin outside the GCNP study area, e.g., Las Vegas, NV, approaches, and lands at GCNP airport.

3 A departure is an activity in which an aircraft departs from GCNP airport, leaves the terminal airspace, and continues on in flight to a destination outside of the GCNP study area.

4 A circuit is an activity in which an aircraft departs from GCNP airport, continues on in flight with various changes in performance and spatial position, approaches, and lands at GCNP airport. A circuit operation is analogous to a GCNP tour operation.

5 An overflight is an activity in which an aircraft that is already in flight continues on in flight, and does not approach and land at any airport within the GCNP study area.

4.1.3 MODEL OUTPUT

All modeling was performed for the No Action and Proposed Alternative described in Chapter 2. For both the No Action and Proposed alternatives, two types of analyses were performed with the INM, a contour analysis and a representative location analysis.

Contours

For the purposes of INM, a set of contours consists of lines of constant noise or time which tend to decrease with increasing distance from an airport or flight track. For the current GCNP analysis, both L_{Aeq12h} and $\%TA_{12h}$ contours were computed for the GCNP study area.

In determining areas encompassed by specific sound level contours, two types of analyses were performed, a wide-area analysis and a GCNP boundary analysis. The wide-area analysis included the entire case analysis window in computing area values encompassed by specific contour levels, an 13,510 square statute mile area. The GCNP boundary analysis included only the area encompassed by the GCNP boundary, an 1,886.79 square statute mile area.

L_{Aeq12h} contours were computed for levels ranging from 10 to 60 dB. $\%TA_{12h}$ contours were computed for 25 percent. Both sets were used in the evaluation of the NPS goal for restoration of natural quiet.

Representative Locations

A set of 48 individual point locations (see Table 4.1.3a) were considered in the analysis as representative of important areas within GCNP, e.g., Native Indian Citizenries and scenic overlooks. Both L_{Aeq12h} and $\%TA_{12h}$ were computed for each representative location. These locations are presented along with a descriptive name, a six character identifier, a latitude, a longitude, and an elevation above mean sea level (MSL).

Given the latitude and longitude for each location, the elevation was obtained using the three-arc-second elevation data from Micropath Corporation of Golden, CO. These data, derived from U.S. Geological Survey information, have been the standard source of terrain data for INM since 1994.

Figure 4-3 displays the individual point locations according to their six-character identifiers. They are overlaid on the GCNP boundary and the Colorado River.

4.1.4 NOISE MODELING RESULTS

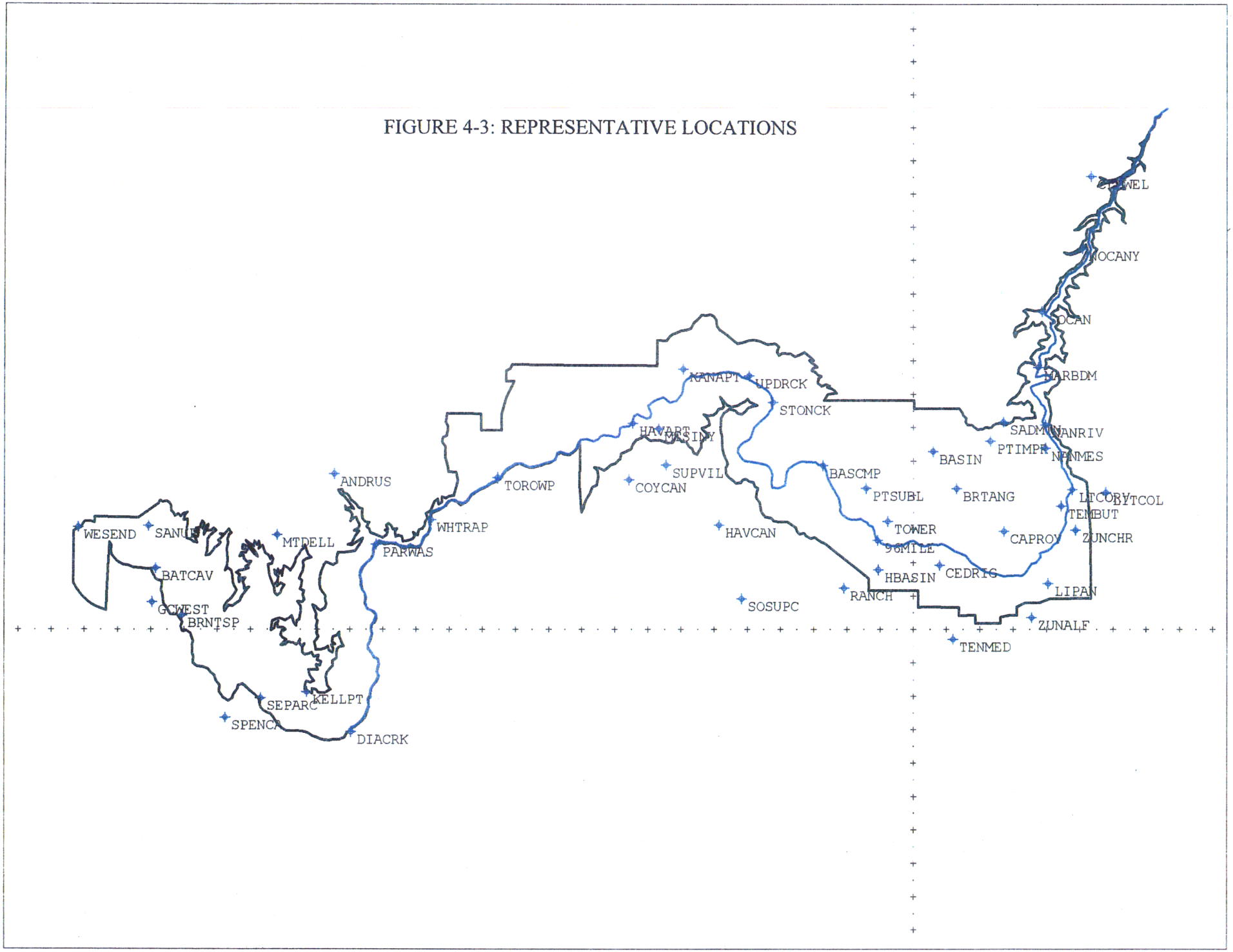
Traditional FAA noise analyses focus on the effects of a particular action on L_{dn} contours, in particular the 65 dB L_{dn} contour. As stated previously, the current analysis has focused on L_{Aeq12h} instead of L_{dn} because of the limited hours of operation in the GCNP (7 a.m. to 7 p.m. during summer time, neglecting the air routes subject to a curfew). Table 4.1.4a and Table 4.1.4b present a comparison of the square statute mile area covered by the L_{Aeq12h} (10 to 60 dB) and TA_{12h} (25 %) contours for the No-Action and the Proposed Alternative. The comparison is presented in terms of both a wide-area analysis and an analysis restricted to the GCNP boundary.

The proposed action will reduce noise levels for the general study area and substantially reduce noise levels within the GCNP boundary. As shown in Figure 4-4, the proposed action if adopted would succeed in

Table 4.1.3a: Representative Locations

Points	Location	Latitude	Longitude	Elevation
1	Andrus Canyon (ANDRUS)	35-13-00.000N	113-25-00.000W	4204
2	Bass Camp (BASCMP)	36-14-14.091N	112-20-39.845W	2201
3	Bat Cave (BATCAV)	36-02-52.800N	113-48-10.200W	2314
4	Burnt Springs Canyon (BRNTSP)	35-57-58.379N	113-44-38.955W	1359
5	Kanab Point (KANAPT)	36-24-15.875N	112-39-04.927W	5449
6	Kelly Point (KELLPT)	35-50-06.186N	113-28-10.443W	6000
7	Mt. Dellenbaugh (MTDELL)	36-06-31.800N	113-32-24.000W	6750
8	Point Sublime (PTSUBL)	36-11-54.012N	112-14-59.113W	7187
9	Sanup (SANUP)	36-07-17.065N	113-49-15.706W	4390
10	Separation Canyon (SEPARC)	35-49-24.232N	113-34-12.258W	1401
11	Stone Creek (STONCK)	36-20-47.881N	112-27-13.878W	2008
12	Toroweap Overlook (TOROWP)	36-12-48.603N	113-03-29.722W	4140
13	Tower of RA (TOWER)	36-08-28.200N	112-12-10.200W	6269
14	Upper Deer Creek (UPDRCK)	36-23-37.457N	112-30-21.754W	2406
15	West End (WESEND)	36-07-00.000N	113-58-27.000W	1014
16	Coyote Canyon (COYCAN)	36-12-42.000N	112-46-09.000W	4677
17	Diamond Creek (DIACRK)	35-45-57.000N	113-22-16.800W	1601
18	Grand Canyon West (GCWEST)	35-59-18.600N	113-48-35.400W	4748
19	Havasu Point (HAVAPT)	36-18-33.059N	112-45-44.203W	1809
20	Havatagvitch Canyon (HAVCAN)	36-08-01.800N	112-34-18.000W	4199
21	Hermit Basin (HBASIN)	36-03-21.827N	112-13-22.679W	5175
22	Mount Sinyala (MTSINY)	36-18-00.000N	112-42-19.800W	5007
23	Parashant Wash (PARWAS)	36-05-40.200N	113-19-19.800W	1703
24	The Ranch (RANCH)	36-01-27.000N	112-17-54.000W	6200
25	South Supai Canyon (SOSUPC)	36-00-19.200N	112-31-16.200W	4403
26	Spencer Canyon (SPENCA)	35-47-15.000N	113-38-45.000W	2790
27	Supai Village (SUPVIL)	36-14-12.338N	112-41-18.816W	3210
28	Whitmore Rapids (WHTRAP)	36-08-20.357N	113-12-11.219W	1680
29	96 Mile Camp (96MILE)	36-06-27.645N	112-13-30.800W	2401
30	The Basin (BASIN)	36-15-42.203N	112-06-10.941W	8198
31	Bright Angel Point (BRTANG)	36-11-53.011N	112-03-06.380W	8151
32	Cape Royal (CAPROY)	36-07-23.034N	111-56-54.549W	7621
33	Cliff Dwellers Lodge (CLDWEL)	36-44-38.400N	111-45-19.800W	4214
34	Marble Canyon Dam Site (MARBDM)	36-24-31.388N	111-52-21.588W	3007
35	Nankoweap Mesa (NANMES)	36-16-00.000N	111-51-28.800W	5391
36	North Canyon (NOCANY)	36-37-00.000N	111-46-30.000W	4457
37	Point Imperial (PTIMPL)	36-16-44.711N	111-58-39.584W	7425
38	Saddle Mountain (SADMTN)	36-18-43.800N	111-56-57.600W	7171
39	South Canyon (SOCAN)	36-30-20.000N	111-51-50.000W	5196
40	Temple Butte (TEMBUT)	36-10-01.200N	111-49-28.200W	3749
41	Cedar Ridge (CEDRIG)	36-03-50.889N	112-05-19.856W	6013
42	Lipan Point (LIPAN)	36-01-55.919N	111-51-12.981W	7063
43	Little Colorado (LITCOL)	36-11-25.200N	111-43-36.000W	5306
44	LittleColorado River (LTCORV)	36-11-45.230N	111-48-01.162W	2913
45	Nankoweap at river (NANRIV)	36-18-26.819N	111-51-27.960W	3254
46	Ten X Meadow (TENMED)	35-56-03.000N	112-03-36.000W	6906
47	Zuni Alpha (ZUNALF)	35-58-19.800N	111-53-21.000W	6859
48	Zuni Charlie (ZUNCHR)	36-07-30.000N	111-47-35.000W	5337

FIGURE 4-3: REPRESENTATIVE LOCATIONS



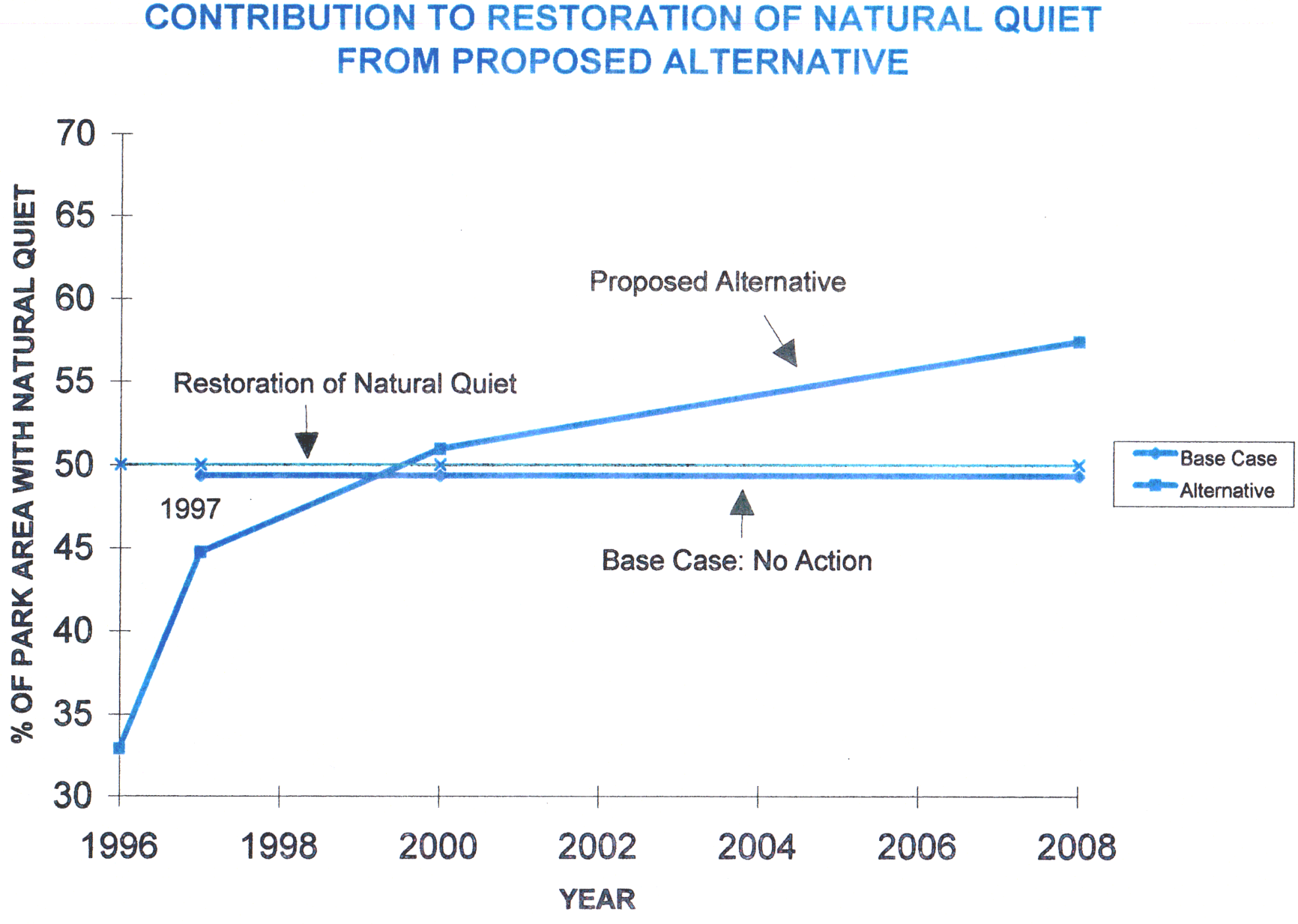

CONTRIBUTION TO RESTORATION OF NATURAL QUIET
FROM PROPOSED ALTERNATIVE
% OF PARK AREA WITH NATURAL QUIET
70
65
60
55
50
45
40
35
30
1996
1998
2000
2002
2004
2006
2008
YEAR
Proposed Alternative
Restoration of Natural Quiet
1997
Base Case: No Action
Base Case
Alternative

Figure 4-4

restoring natural quiet in the GCNP by the year 2000. The results indicate that 51 percent of the GCNP will achieve restoration of natural quiet by 2000, a substantial improvement over the 1996 condition of 33 percent under SFAR 50-2. The 1997 No Action Alternative level of 49 percent includes the benefit of approximately 6 percentage points for new airspace and 6 percentage points for the temporary cap and east-end curfew combined. The difference between 1997 levels for the No Action and Proposed Alternatives is due primarily to the use of the National Canyon Corridor by Category C aircraft under the Proposed Alternative. Finally, the proposed action will generate increased noise benefits through the year 2008, when the analysis shows that more than 57 percent of the GCNP will be restored to natural quiet.

In comparing the two alternatives for 1997 (Table 4.1.4a), a slight increase in square mile area covered is observed for the Proposed Alternative for all but one L_{Aeq12h} wide-area contour level. The reason for the slight increase is readily apparent when the parameters of the specific alternatives are examined. Specifically, in the case of the Proposed Alternative, use of the National Canyon Corridor is allowed for the quieter, Category C aircraft. This provision is not included in the No-Action Alternative. Although the use of this track is restricted to the quieter category aircraft, the simple fact that aircraft are distributed along two unique tracks instead of one results in an increase in affected area. The increase is realized to a slightly larger degree in the case of the GCNP analysis as compared to the wide-area analysis, and the reason for this is that much of the incentive corridor is contained within the GCNP boundary. These results are visually apparent when examining the L_{Aeq12h} contours for the two alternatives in 1997. (see Figures 4-6 and 4-7). Consistent results were observed for $\%TA_{12h}$, as shown in Table 4.1.4b and Figures 4-11 and 4-12.

As discussed previously, the phaseout of the noisier Category A aircraft begins in 1998 (in the case of the Proposed Alternative), so that by the year 2000 the GCNP fleet is made up of entirely Category B and C aircraft. The effects of the phaseout on the square mile L_{Aeq12h} contour area is readily apparent in Table 4.1.4a for the year 2000. With one exception, the square mile area covered by all values of L_{Aeq12h} has been reduced substantially, by as much 36 percent in the case of the 50 dB L_{Aeq12h} contour (wide-area analysis). These reductions are visually apparent when examining the contours for both alternatives in 2000, Figure 4-6 and 4-8. Consistent results were observed for $\%TA_{12h}$, as shown in Table 4.1.4b and Figures 4-11 and 4-13.

By the year 2008 the reduction in square mile area covered by the L_{Aeq12h} contours is even more substantial, ranging from 21 to 67 percent in the case of the wide-area analysis, and 11 to 83 percent in the case of the analysis restricted to within the GCNP boundary. The driving factor behind the significant improvement in 2008 (with the Proposed Alternative) is the fact that Category B aircraft have been phased out in favor of Category C aircraft, such that by 2008 the entire GCNP fleet is Category C. These reductions are readily apparent when looking at the contours for both alternatives in 2008, Figure 4-6 and 4-9. Consistent results were observed for $\%TA_{12h}$, as shown in Table 4.1.4b and Figures 4-11 and 4-14.

Tables 4.1.4c, 4.1.4d, 4.1.4e and 4.1.4f show the L_{Aeq12h} for 48 representative locations in each of the two alternatives. All values are well below the impact criteria of 68 dB

L_{Aeq12h} as defined by the Part 150 criteria outlined above. The Proposed Action, therefore meets the objective of causing no significant impact for any locations within the study area.

In the Dragon Corridor, the Proposed Alternative provides additional noise reduction to that already provided by the December 31, 1996 rule. Projected L_{Aeq12h} reductions for the vicinity of the Dragon Corridor for the Proposed Action were analyzed for representative locations at Hermit Basin, 96 Mile Camp, the Basin, Bright Angel Point, the Tower of RA and Bass Camp. Reductions at these locations for 2000 and 2008 respectively were as follows:

Hermit Basin	(-0.7, -5.8),
96 Mile Camp	(-0.3, -4.6),
The Basin	(-0.6, -4.6),
Bright Angel Point	(-0.6, -7.3),
Tower of Ra	(0.0, -4.8),
Bass Camp	(-0.8, -6.3)

4.1.5 CONCLUSIONS

The analysis presented here indicates that within the analysis area as shown in Figure 1-1 the noise environment as a whole is improved by the proposed action. Although a modest degradation in the noise environment would be realized in 1997 with the Proposed Alternative, by the year 2000 a substantial improvement would result, with continued improvement through the year 2008. The expected improvement is not just limited to the immediate vicinity of GCNP, but also extends beyond the boundaries of the Park to include the entire analysis area. Both the L_{Aeq12h} and the $\%TA_{12h}$ contours support these conclusions.

In terms of the NPS criterion requiring that natural quiet be restored to 50% of the Park, the Proposed Action results in 51 percent restoration by 2000, and further gains by 2008 (57% restoration).

4.2 HISTORIC, ARCHEOLOGICAL, AND CULTURAL RESOURCES

Sec. 110 of the National Historic Preservation Act of 1966, as amended, requires Federal agencies to consult under Sec. 106 with State Historic Preservation Officers, tribes, and interested parties concerning proposed Federal actions that may affect properties included in or eligible for the National Register of Historic Places, including National Historic Landmarks and World Heritage Sites. The regulations governing Sec. 106 consultation are 36 CFR 800.

The Archeological and Historic Preservation Act of 1974 provides for the survey and preservation of significant cultural resources that may be lost due to a Federal project. NEPA also requires consideration of impacts on natural and cultural resources. These resources may include, e.g., National Natural Landmarks as well as National Historic Landmarks both of which are established under the Historic Sites Act of 1935.

Under the requirements of the National Historic Preservation Act, a review of properties in or eligible for inclusion in the National Register of Historic Places located within the vicinity of the GCNP, or area of potential effects, was conducted during the preparation of the EA for the Final Rule establishing subpart U. This review indicated that GCNP and surrounding areas within the area of potential effects contain a

Table 4.1.4a
Comparison of L_{Aeq12h} Contours (10-60 dB) in Square Miles
No Action Alternative and Proposed Alternative

Analysis	Contour Level (dB)	Base Condition 1996	No Action (1997 and Future Years)	Proposed Action 1997		Proposed Action 2000		Proposed Action 2008	
		Sq. Mi.	Sq. Mi.	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area
W I D E	10	8510.3	8158.0	8205.0	0.58	7368.7	-9.68	5519.9	-32.34
	20	4465.8	4152.4	4293.3	3.39	3899.5	-6.09	3214.0	-22.60
	30	2237.6	2149.6	2252.3	4.78	1945.2	-9.51	1680.9	-21.80
	40	805.3	758.7	754.6	-0.54	545.2	-28.14	442.5	-41.67
	50	45.7	41.6	41.6	0.00	26.6	-36.02	18.6	-55.26
	60	4.4	4.1	4.1	0.00	2.9	-29.41	1.3	-67.16
G C N P	10	1876.9	1833.9	1856.9	1.25	1796.8	-2.02	1629.1	-11.17
	20	1402.2	1181.7	1284.2	8.68	1203.7	1.87	977.4	-17.29
	30	632.5	537.0	570.6	6.25	514.4	-4.22	424.2	-21.01
	40	193.6	165.9	166.7	0.46	134.3	-19.04	65.9	-60.30
	50	3.0	2.5	2.5	0.00	1.7	-30.40	0.4	-82.80
	60	0.0	0.0	0.0	0.00	0.0	0.00	0.0	0.00

Table 4.1.4b
Comparison of Square Mile Area Covered by 25%TA_{12h} Contour
No Action Alternative and Proposed Alternative

Case	Analysis	Base Cases 1996	No Action (1997 and Future Years)	Proposed Action 1997		Proposed Action 2000		Proposed Action 2008	
		Sq. Mi.	Sq. Mi.	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area	Sq. Mi.	% Change in Sq. Mi. Area
Rule with Phase-Out, Proposed Alternative	Wide	3479.0	3075.9	3226.5	4.9	2792.8	-9.2	2378.0	-22.7
	GCNP	1161.8	957.0	1043.7	9.1	925.6	-3.3	804.1	-16.0

Table 4.1.4c
Comparison of L_{Aeq12h} at Representative Locations in GCNP: North of Colorado River, West of GC Airport
No-Action Alternative and Proposed Alternative

Location	Base Cases 1996	No Action (1997 and Future Years)	Proposed Action 1997		Proposed Action 2000		Proposed Action 2008	
	L_{Aeq12h}	L_{Aeq12h}	L_{Aeq12h}	Change in Level	L_{Aeq12h}	Change in Level	L_{Aeq12h}	Change in Level
Andrus Canyon (ANDRUS)	23.9	23.8	23.8	0.0	21.0	-2.8	19.3	-4.5
Bass Camp (BASCMP)	21.4	20.7	20.7	0.0	19.9	-0.8	14.4	-6.3
Bat Cave (BATCAV)	42.8	42.7	42.7	0.0	41.8	-0.9	37.3	-5.4
Burnt Springs Canyon (BRNTSP)	42.4	42.3	42.3	0.0	41.2	-1.1	36.6	-5.7
Kanab Point (KANAPT)	16.7	10.2	12.0	1.8	10.9	0.7	11.9	1.7
Kelly Point (KELLPT)	16.5	16.5	16.5	0.0	14.5	-2.0	10.0	-6.5
Mt. Dellenbaugh (MTDELL)	50.9	50.8	50.8	0.0	48.4	-2.4	49.1	-1.7
Point Sublime (PTSUBL)	30.9	30.3	30.3	0.0	29.8	-0.5	26.9	-3.4
Sanup (SANUP)	41.4	41.3	41.3	0.0	38.9	-2.4	39.1	-2.2
Separation Canyon (SEPARC)	28.9	28.8	28.8	0.0	26.8	-2.0	22.3	-6.5
Stone Creek (STONCK)	16.6	14.0	14.3	0.3	13.2	-0.8	9.9	-4.1
Toroweap Overlook (TOROWP)	33.5	28.4	30.5	2.1	29.1	0.7	31.0	2.6
Tower of RA (TOWER)	45.1	44.5	44.5	0.0	44.5	0.0	39.7	-4.8
Upper Deer Creek (UPDRCK)	15.2	11.9	12.4	0.5	11.3	-0.6	8.8	-3.1
West End (WESEND)	39.9	39.9	39.9	0.0	38.1	-1.8	35.1	-4.8

Table 4.1.4d
Comparison of L_{Aeq12h} at Representative Locations in GCNP: South of Colorado River, West of GC Airport
No-Action Alternative and Proposed Alternative

Location	Base Cases 1996	No Action (1997 and Future Years	Proposed Action 1997		Proposed Action 2000		Proposed Action 2008	
	L_{Aeq12h}	L_{Aeq12h}	L_{Aeq12h}	Change in Level	L_{Aeq12h}	Change in Level	L_{Aeq12h}	Change in Level
96 Mile Camp (96MILE)	34.7	34.1	34.1	0.0	33.8	-0.3	29.5	-4.6
Coyote Canyon (COYCAN)	33.2	22.9	28.5	5.6	27.9	5.0	30.7	7.8
Diamond Creek (DIACRK)	13.3	13.3	13.3	0.0	10.7	-2.6	6.1	-7.2
Grand Canyon West (GCWEST)	36.3	36.2	36.2	0.0	35.8	-0.4	31.4	-4.8
Havasu Point (HAVAPT)	28.9	15.0	22.9	7.9	22.5	7.5	25.7	10.7
Havatagvitch Canyon (HAVCAN)	38.5	33.8	35.9	2.1	34.5	0.7	36.5	2.7
Hermit Basin (HBASIN)	33.2	32.7	32.7	0.0	32.0	-0.7	26.9	-5.8
Mount Sinyala (MTSINY)	43.8	19.5	38.8	19.3	38.7	19.2	42.0	22.5
Parashant Wash (PARWAS)	38.1	38.0	38.0	0.0	35.6	-2.4	36.0	-2.0
The Ranch (RANCH)	35.0	34.5	34.5	0.0	33.6	-0.9	29.5	-5.0
South Supai Canyon (SOSUPC)	36.7	36.6	36.6	0.0	34.2	-2.4	34.6	-2.0
Spencer Canyon (SPENCA)	43.0	42.9	42.9	0.0	40.7	-2.2	36.1	-6.8
Supai Village (SUPVIL)	32.2	19.3	26.6	7.3	26.2	6.9	29.3	10.0
Whitmore Rapids (WHTRAP)	34.8	34.8	34.8	0.0	32.2	-2.6	32.1	-2.7

Table 4.1.4e
Comparison of L_{Aeq12h} at Representative Locations in GCNP: North of Colorado River, East of GC Airport
No-Action Alternative and Proposed Alternative

Location	Base Cases 1996	No Action (1997 and Future Years	Proposed Action 1997		Proposed Action 2000		Proposed Action 2008	
	L_{Aeq12h}	L_{Aeq12h}	L_{Aeq12h}	Change in Level	L_{Aeq12h}	Change in Level	L_{Aeq12h}	Change in Level
The Basin (BASIN)	25.5	24.9	24.9	0.0	24.3	-0.6	20.3	-4.6
Bright Angel Point (BRTANG)	22.5	22.0	22.0	0.0	21.4	-0.6	14.7	-7.3
Cape Royal (CAPROY)	28.3	27.7	27.7	0.0	27.1	-0.6	24.2	-3.5
Cliff Dwellers Lodge (CLDWEL)	17.0	16.4	16.4	0.0	14.9	-1.5	10.2	-6.2
Marble Canyon Dam Site (MARBDM)	20.4	19.8	19.8	0.0	19.4	-0.4	10.9	-8.9
Nankoweap Mesa (NANMES)	31.9	31.3	31.3	0.0	30.8	-0.5	28.1	-3.2
North Canyon (NOCANY)	10.2	9.6	9.6	0.0	8.7	-0.9	1.6	-8.0
Point Imperial (PTIMPL)	32.5	31.9	31.9	0.0	31.8	-0.1	24.0	-7.9
Saddle Mountain (SADMTN)	49.4	48.8	48.8	0.0	48.8	0.0	41.1	-7.7
South Canyon (SOCAN)	15.1	14.5	14.5	0.0	13.7	-0.8	6.6	-7.9
Temple Butte (TEMBUT)	30.1	29.5	29.5	0.0	28.9	-0.6	26.3	-3.2

Table 4.1.4f
Comparison of L_{Aeq12h} at Representative Locations in GCNP: South of Colorado River, East of GC Airport
No-Action Alternative and Proposed Alternative

Location	Base Cases 1996	No Action 1997 and Future Years	Proposed Action 1997		Proposed Action 2000		Proposed Action 2008	
	L_{Aeq12h}	L_{Aeq12h}	L_{Aeq12h}	Change in Level	L_{Aeq12h}	Change in Level	L_{Aeq12h}	Change in Level
Cedar Ridge (CEDRIG)	27.8	27.5	27.5	0.0	25.9	-1.6	21.0	-6.5
Lipan Point (LIPAN)	32.2	31.6	31.6	0.0	31.0	-0.6	28.9	-2.7
Little Colorado (LITCOL)	39.5	38.9	38.9	0.0	38.6	-0.3	36.5	-2.4
Little Colorado River(LTCORV)	28.8	28.2	28.2	0.0	27.6	-0.6	24.2	-4.0
Nankoweap at river (NANRIV)	28.7	28.1	28.1	0.0	27.8	-0.3	20.6	-7.5
Ten X Meadow (TENMED)	44.3	43.7	43.7	0.0	43.2	-0.5	41.5	-2.2
Zuni Alpha (ZUNALF)	42.4	41.8	41.8	0.0	41.4	-0.4	39.8	-2.0
Zuni Charlie (ZUNCHR)	26.6	26.0	26.0	0.0	25.4	-0.6	21.5	-4.5

Table 4.1.4g
Comparison of %TA (12h) at Representative Locations in GCNP: North of Colorado River, West of GC Airport
No-Action Alternative and Proposed Alternative

Location	Base Cases 1996	No Action 1997 and Future Years	Proposed Action 1997		Proposed Action 2000		Proposed Action 2008	
	%TA (12h)	%TA (12h)	%TA (12h)	Change in %	%TA (12h)	Change in %	%TA (12h)	Change in %
Andrus Canyon (ANDRUS)	35.1	34.7	34.7	0.0	20.0	-14.7	13.6	-21.1
Bass Camp (BASCMP)	53.6	43.3	43.3	0.0	36.8	-6.5	7.9	-35.4
Bat Cave (BATCAV)	100.0	100.0	100.0	0.0	100.0	0.0	97.8	-2.2
Burnt Springs Canyon (BRNTSP)	76.7	75.4	75.4	0.0	46.3	-29.1	37.4	-38.0
Kanab Point (KANAPT)	12.3	0.0	0.7	0.7	0.7	0.7	1.2	1.2
Kelly Point (KELLPT)	8.7	8.5	8.5	0.0	7.4	-1.1	1.6	-6.9
Mt. Dellenbaugh (MTDELL)	72.1	70.9	70.9	0.0	62.4	-8.5	69.5	-1.4
Point Sublime (PTSUBL)	51.3	45.1	45.1	0.0	42.0	-3.1	27.0	-18.1
Sanup (SANUP)	100.0	100.0	100.0	0.0	100.0	0.0	100.0	0.0
Separation Canyon (SEPARC)	18.6	18.3	18.3	0.0	16.8	-1.5	12.9	-5.4
Stone Creek (STONCK)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Toroweap Overlook (TOROWP)	62.1	52.9	56.6	3.7	41.5	-11.4	48.5	-4.4
Tower of RA (TOWER)	47.0	41.9	41.9	0.0	39.5	-2.4	24.5	-17.4
Upper Deer Creek (UPDRCK)	13.2	3.7	3.7	0.0	2.4	-1.3	0.0	-3.7
West End (WESEND)	100.0	100.0	100.0	0.0	100.0	0.0	100.0	0.0

Table 4.1.4h
Comparison of %TA (12h) at Representative Locations in GCNP: South of Colorado River, West of GC Airport
No-Action Alternative and Proposed Alternative

Location	Bases Cases 1996	No Action 1997 and Future Years	Proposed Action 1997		Proposed Action 2000		Proposed Action 2008	
	%TA (12h)	%TA (12h)	%TA (12h)	Change in %	%TA (12h)	Change in %	%TA (12h)	Change in %
96 Mile Camp (96MILE)	22.6	20.0	20.0	0.0	17.4	-2.6	11.4	-8.6
Coyote Canyon (COYCAN)	36.7	24.0	31.8	7.8	26.5	2.5	34.6	10.6
Diamond Creek (DIACRK)	2.1	2.1	2.1	0.0	0.1	-2.0	0.1	-2.0
Grand Canyon West (GCWEST)	55.2	54.3	54.3	0.0	48.6	-5.7	36.1	-18.2
Havasu Point (HAVAPT)	46.0	10.6	26.4	15.8	15.9	5.3	41.8	31.2
Havatagvitch Canyon (HAVCAN)	44.0	42.9	43.6	0.7	34.9	-8.0	38.3	-4.6
Hermit Basin (HBASIN)	98.6	89.7	89.7	0.0	76.8	-12.9	52.7	-37.0
Mount Sinyala (MTSINY)	54.0	9.7	29.8	20.1	20.2	10.5	51.5	41.8
Parashant Wash (PARWAS)	100.0	100.0	100.0	0.0	94.7	-5.3	99.4	-0.6
The Ranch (RANCH)	100.0	100.0	100.0	0.0	99.5	-0.5	79.0	-21.0
South Supai Canyon (SOSUPC)	83.4	82.1	81.9	-0.2	72.7	-9.4	70.3	-11.8
Spencer Canyon (SPENCA)	21.6	21.2	21.2	0.0	19.1	-2.1	16.2	-5.0
Supai Village (SUPVIL)	41.0	10.8	24.9	14.1	14.2	3.4	37.1	26.3
Whitmore Rapids (WHTRAP)	100.0	100.0	100.0	0.0	100.0	0.0	100.0	0.0

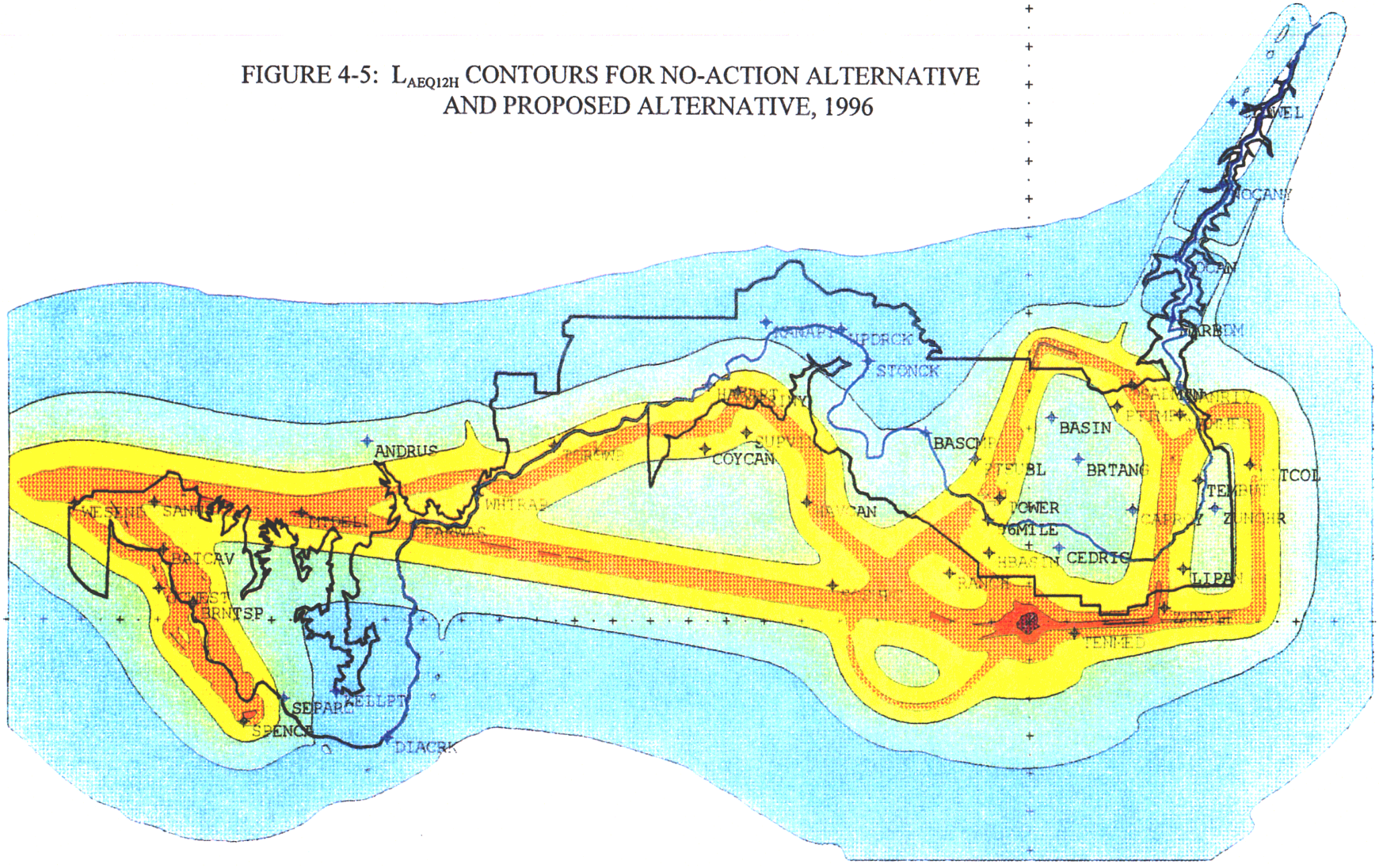
Table 4.1.4i
Comparison of %TA (12h) at Representative Locations in GCNP: North of Colorado River, East of GC Airport
No-Action Alternative and Proposed Alternative

Location	Base Cases 1996	No Action 1997 and Future Years	Proposed Action 1997		Proposed Action 2000		Proposed Action 2008	
	%TA (12h)	%TA (12h)	%TA (12h)	Change in %	%TA (12h)	Change in %	%TA (12h)	Change in %
The Basin (BASIN)	28.5	25.0	25.0	0.0	22.7	-2.3	14.0	-11.0
Bright Angel Point (BRTANG)	4.4	3.9	3.9	0.0	3.5	-0.4	0.0	-3.9
Cape Royal (CAPROY)	32.7	28.7	28.7	0.0	26.6	-2.1	18.3	-10.4
Cliff Dwellers Lodge (CLDWEL)	0.2	0.2	0.2	0.0	0.1	-0.1	0.1	-0.1
Marble Canyon Dam Site (MARBDM)	20.7	18.1	18.1	0.0	15.2	-2.9	4.8	-13.3
Nankoweap Mesa (NANMES)	31.5	27.5	27.5	0.0	26.8	-0.7	22.3	-5.2
North Canyon (NOCANY)	1.9	1.6	1.6	0.0	1.6	0.0	0.2	-1.4
Point Imperial (PTIMPL)	14.4	12.5	12.5	0.0	12.1	-0.4	8.9	-3.6
Saddle Mountain (SADMTN)	25.7	22.4	22.4	0.0	21.0	-1.4	13.7	-8.7
South Canyon (SOCAN)	4.0	3.5	3.5	0.0	3.0	-0.5	0.3	-3.2
Temple Butte (TEMBUT)	71.2	62.3	62.3	0.0	59.0	-3.3	45.5	-16.8

Table 4.1.4j
Comparison of %TA (12h) at Representative Locations in GCNP: South of Colorado River, East of GC Airport
No-Action Alternative and Proposed Alternative

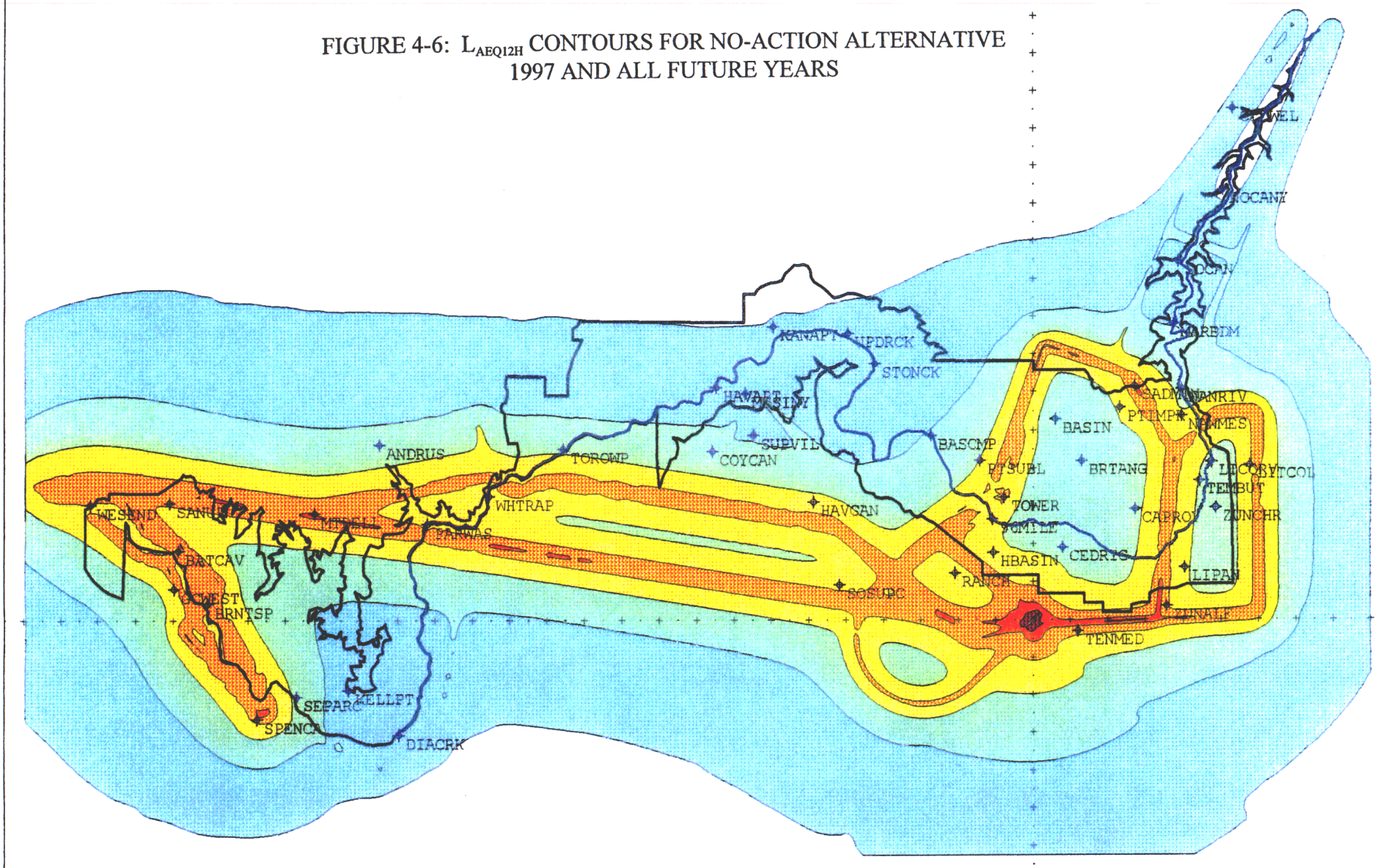
Location	Base Cases 1996	No Action 1997 and Future Years	Proposed Action 1997		Proposed Action 2000		Proposed Action 2008	
	%TA (12h)	%TA (12h)	%TA (12h)	Change in %	%TA (12h)	Change in %	%TA (12h)	Change in %
Cedar Ridge (CEDRIG)	52.7	47.9	47.9	0.0	40.5	-7.4	25.0	-22.9
Lipan Point (LIPAN)	62.9	55.2	55.2	0.0	52.8	-2.4	40.3	-14.9
Little Colorado (LITCOL)	29.4	25.6	25.6	0.0	23.7	-1.9	18.6	-7.0
Little Colorado River (LTCORV)	76.2	66.7	66.7	0.0	63.6	-3.1	46.9	-19.8
Nankoweap at river (NANRIV)	51.4	45.0	45.0	0.0	42.8	-2.2	31.2	-13.8
Ten X Meadow (TENMED)	100.0	93.5	93.5	0.0	87.8	-5.7	78.6	-14.9
Zuni Alpha (ZUNALF)	62.9	55.3	55.3	0.0	52.9	-2.4	43.9	-11.4
Zuni Charlie (ZUNCHR)	77.6	68.0	68.0	0.0	64.1	-3.9	44.8	-23.2

FIGURE 4-5: L_{AEQ12H} CONTOURS FOR NO-ACTION ALTERNATIVE AND PROPOSED ALTERNATIVE, 1996



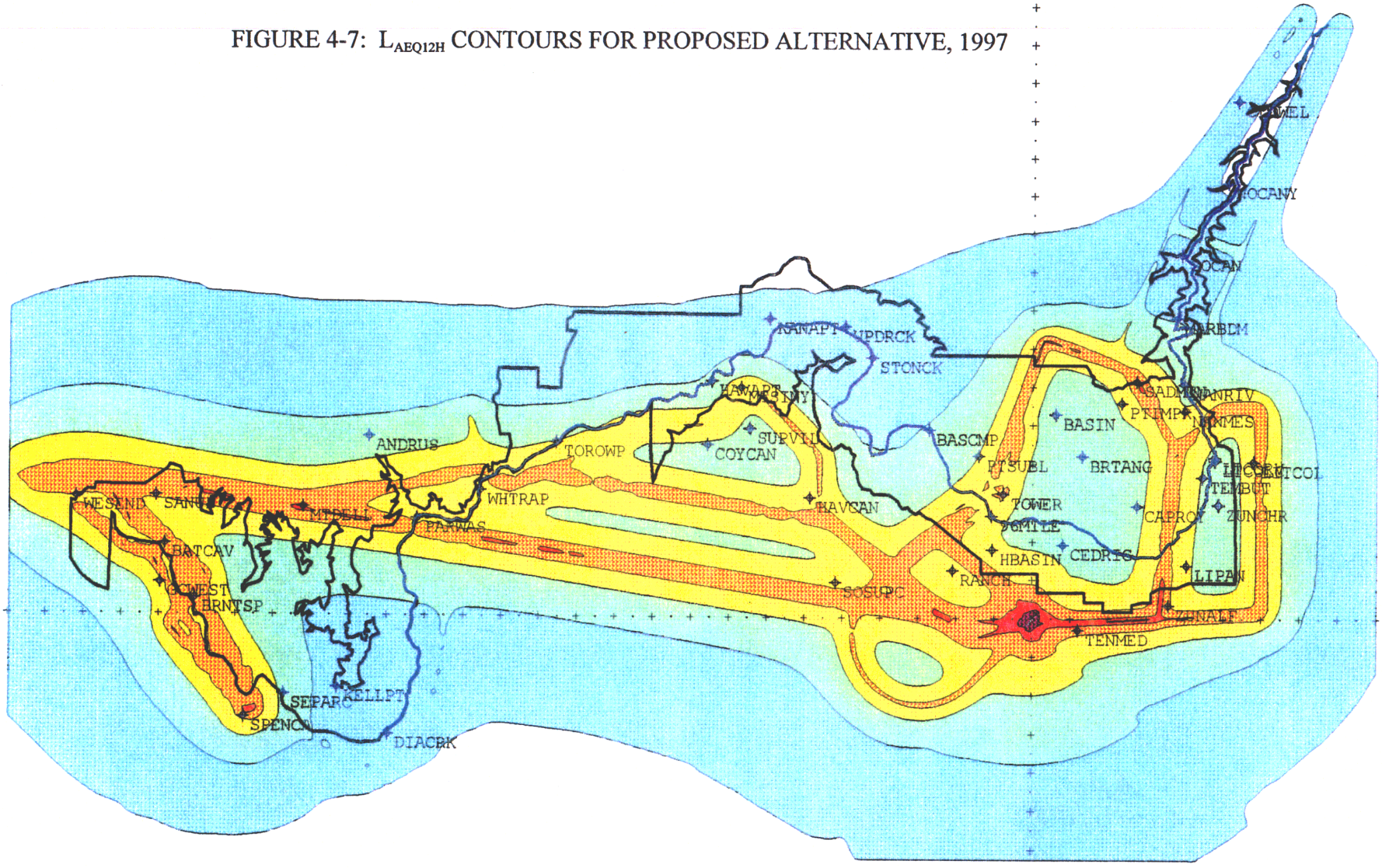
GCNFEAA1\A962LQ12.OUT	Level:	10	20	30	40	50	60
Grid Size: 3.52 nmi	Area:	8510.30	4465.75	2237.63	805.25	45.70	4.39
Metric: LEQ12	Color:						

FIGURE 4-6: L_{AEQ12H} CONTOURS FOR NO-ACTION ALTERNATIVE
1997 AND ALL FUTURE YEARS



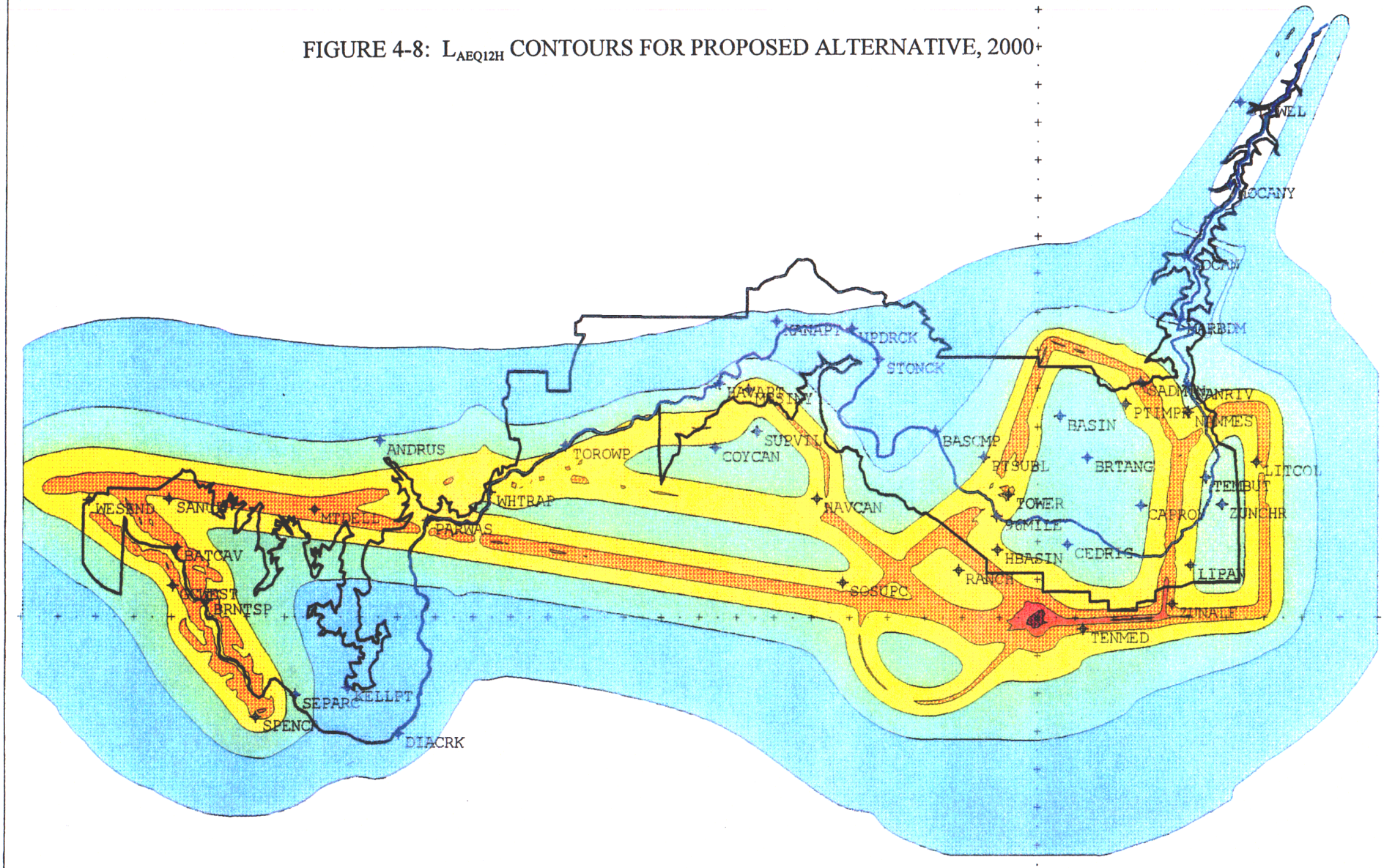
GCNFEAA1\A972LQ12.OUT	Level:	10	20	30	40	50	60
Grid Size: 3.52 nmi	Area:	8158.03	4152.44	2149.55	758.72	41.64	4.08
Metric: LEQ12	Color:						

FIGURE 4-7: L_{AEQ12H} CONTOURS FOR PROPOSED ALTERNATIVE, 1997



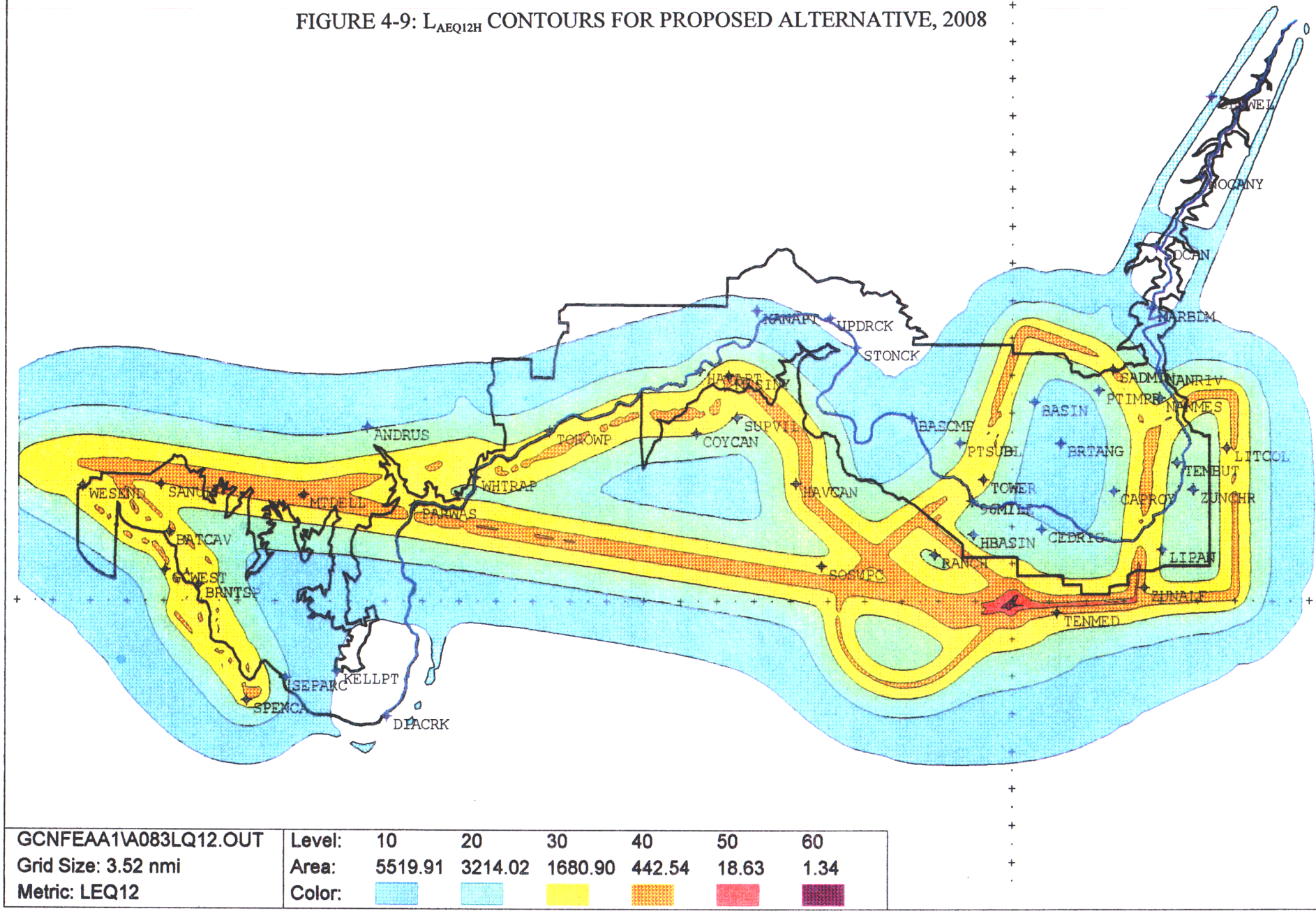
GCNFEAA1\A973LQ12.OUT	Level:	10	20	30	40	50	60
Grid Size: 3.52 nmi	Area:	8204.95	4293.33	2252.30	754.60	41.64	4.08
Metric: LEQ12	Color:						

FIGURE 4-8: L_{AEQ12H} CONTOURS FOR PROPOSED ALTERNATIVE, 2000



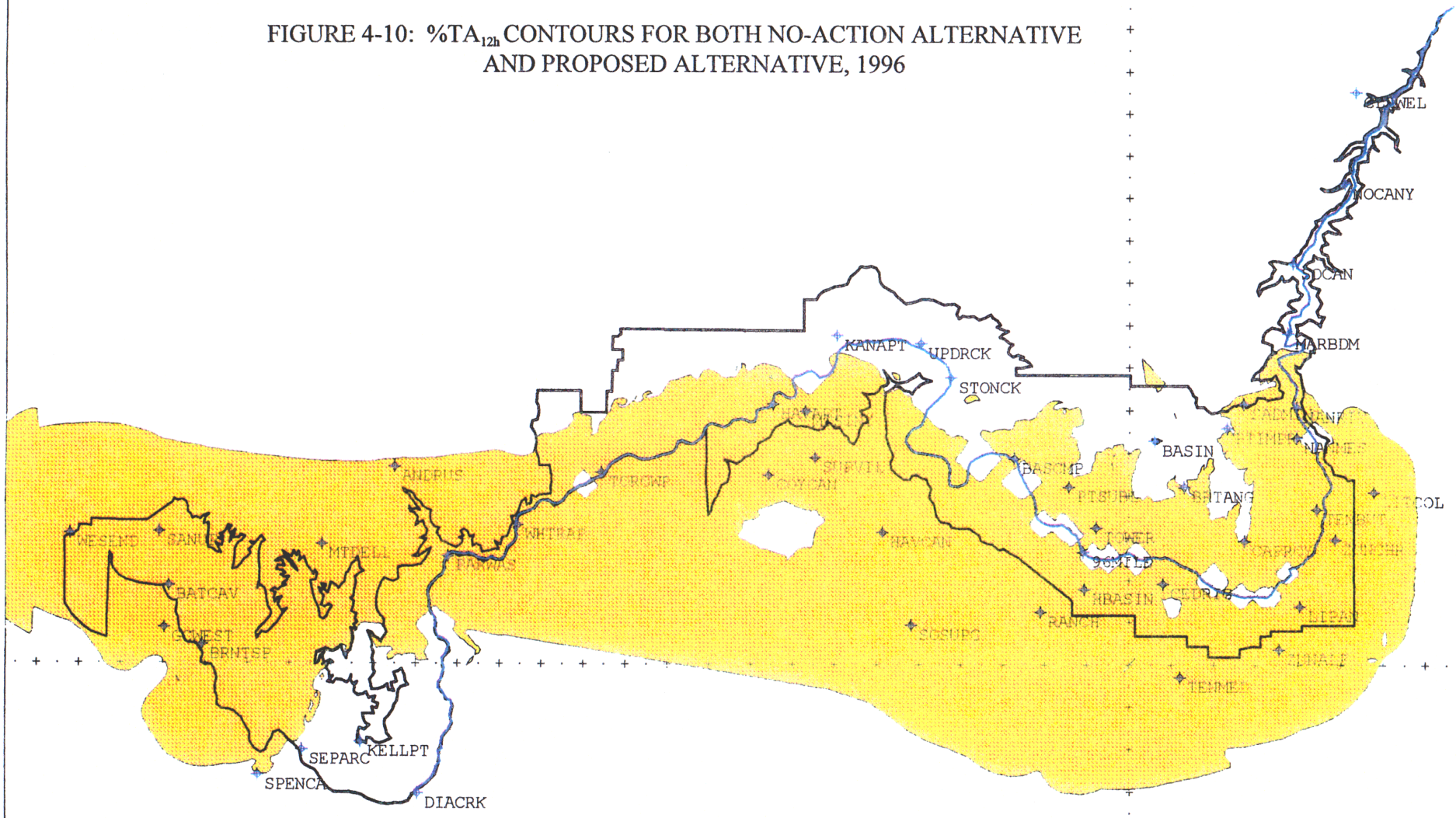
GCNFEAA1\A003LQ12.OUT	Level:	10	20	30	40	50	60
Grid Size: 3.52 nmi	Area:	7368.74	3899.54	1945.17	545.21	26.64	2.88
Metric: LEQ12	Color:						

FIGURE 4-9: L_{AEQ12H} CONTOURS FOR PROPOSED ALTERNATIVE, 2008



GCNFEAA1\A083LQ12.OUT	Level:	10	20	30	40	50	60
Grid Size: 3.52 nmi	Area:	5519.91	3214.02	1680.90	442.54	18.63	1.34
Metric: LEQ12	Color:						

FIGURE 4-10: $\%TA_{12h}$ CONTOURS FOR BOTH NO-ACTION ALTERNATIVE AND PROPOSED ALTERNATIVE, 1996



GCNFEAA1\A962TA12.OUT	Level:	25
Grid Size: 3.52 nmi	Area:	3478.96
Metric: TALA	Color:	

FIGURE 4-11: $\%TA_{12h}$ CONTOURS FOR NO-ACTION ALTERNATIVE, 1997 AND ALL FUTURE YEARS

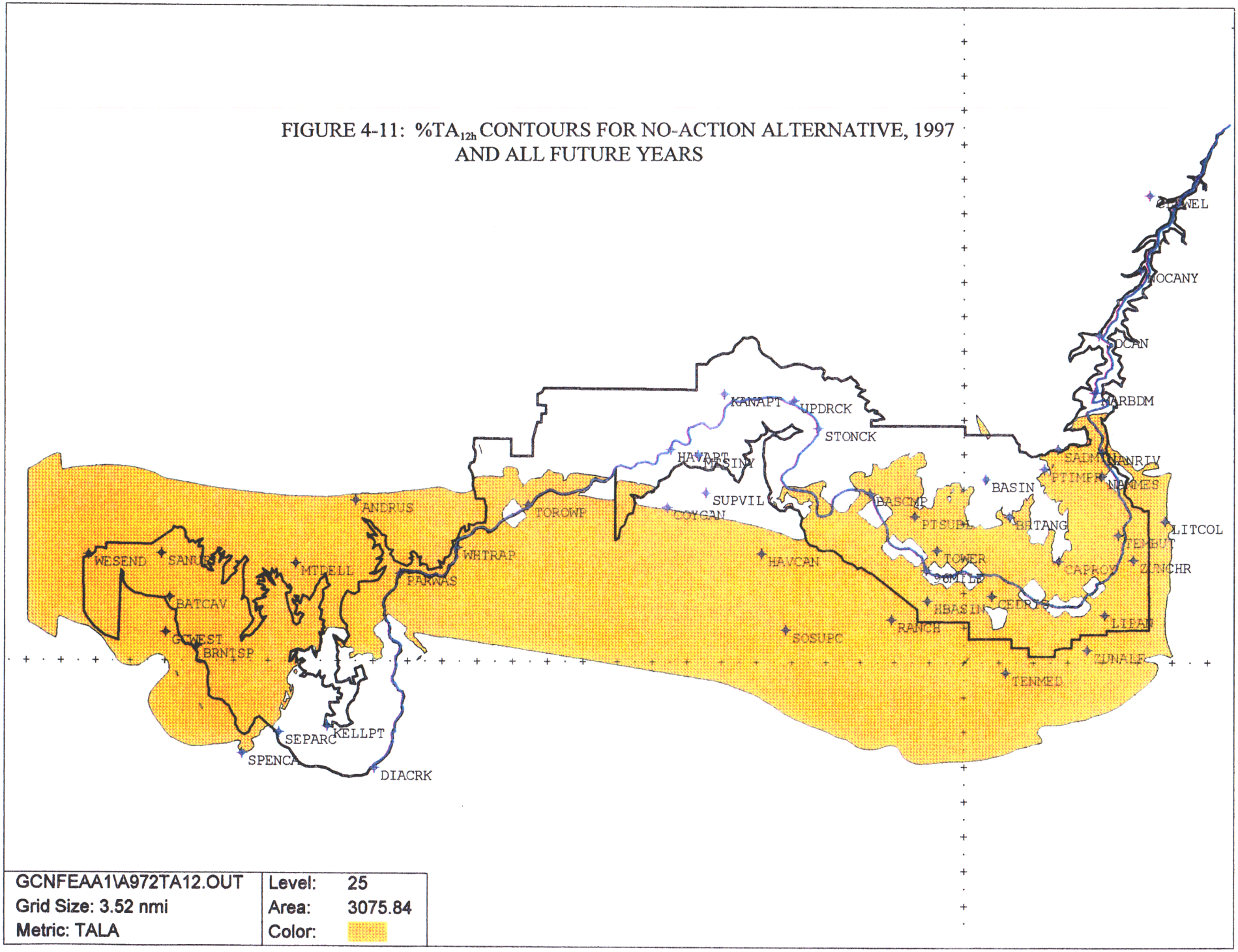
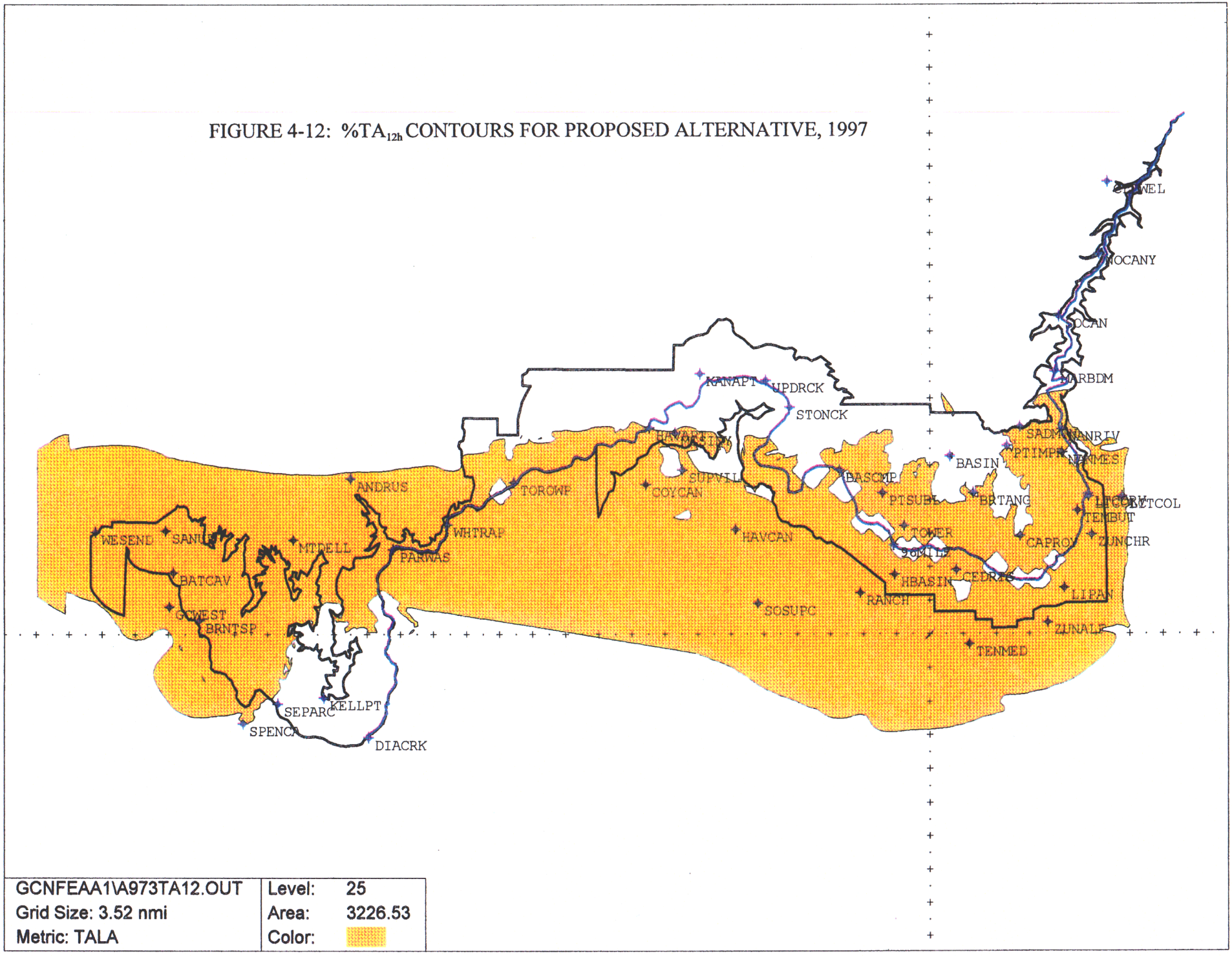
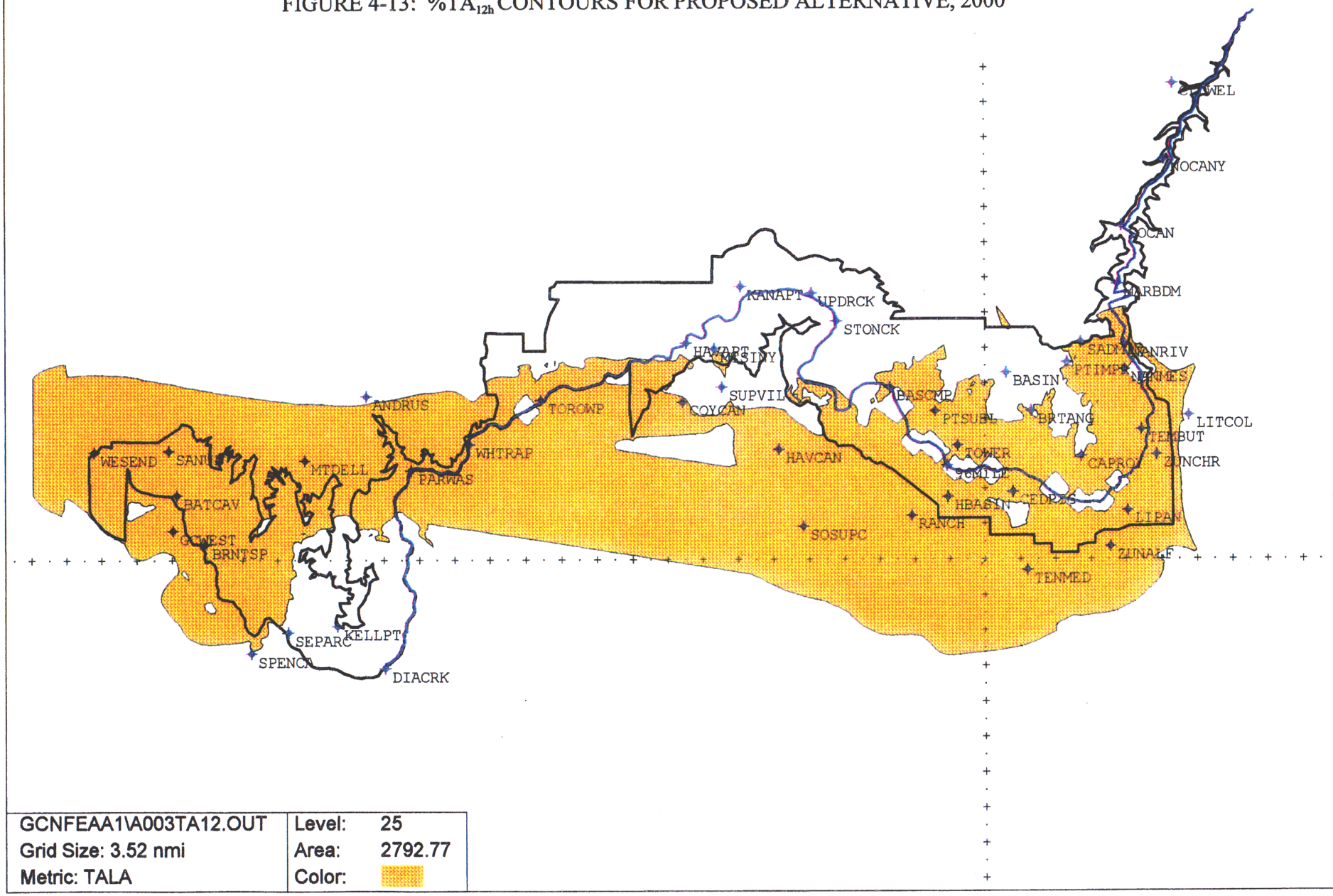


FIGURE 4-12: $\%TA_{12h}$ CONTOURS FOR PROPOSED ALTERNATIVE, 1997



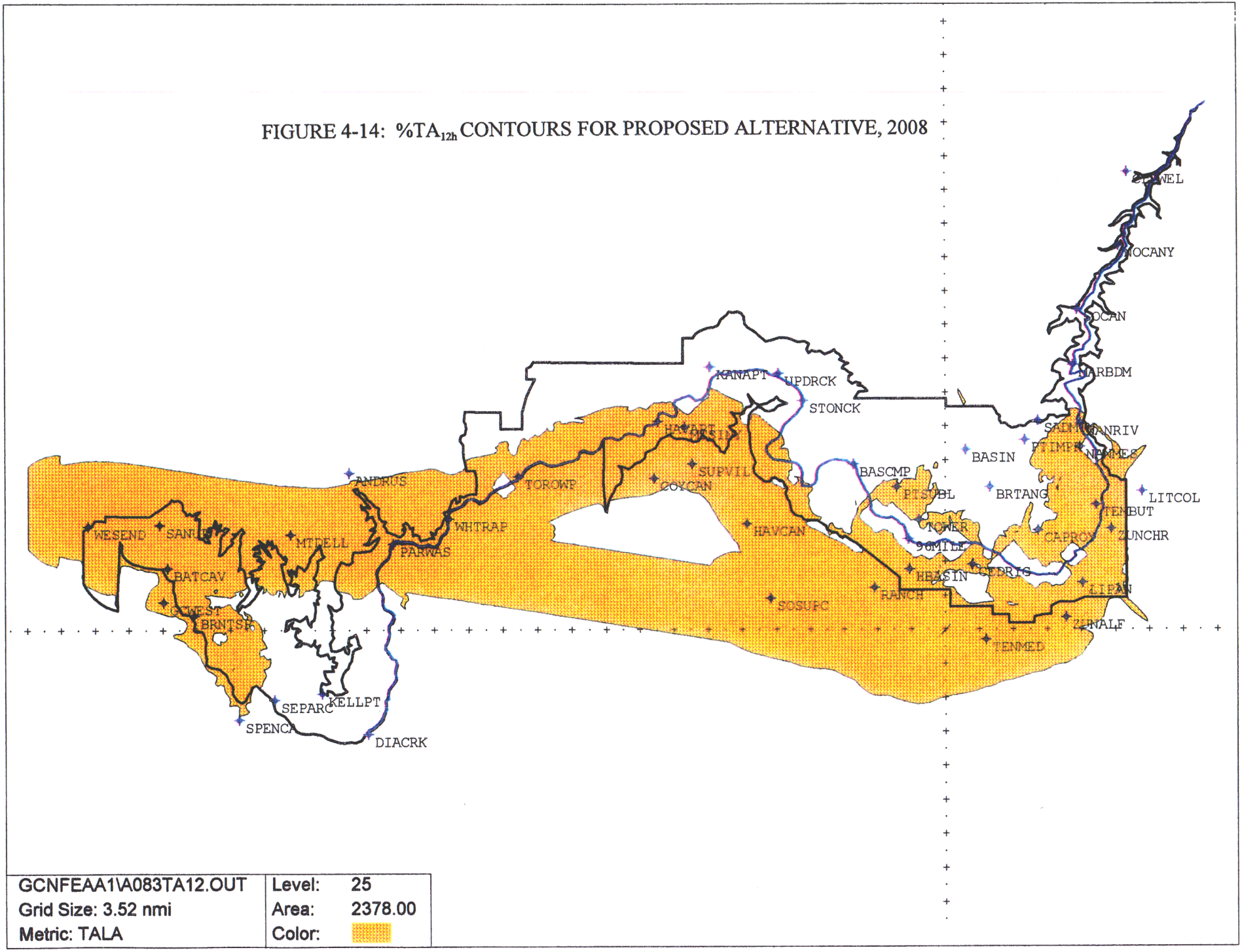
GCNFEAA1\A973TA12.OUT	Level: 25
Grid Size: 3.52 nmi	Area: 3226.53
Metric: TALA	Color:

FIGURE 4-13: $\%TA_{12h}$ CONTOURS FOR PROPOSED ALTERNATIVE, 2000



GCNFEAA1\A003TA12.OUT	Level: 25
Grid Size: 3.52 nmi	Area: 2792.77
Metric: TALA	Color:

FIGURE 4-14: $\%TA_{12h}$ CONTOURS FOR PROPOSED ALTERNATIVE, 2008



GCNFEAA1\A083TA12.OUT	Level:	25
Grid Size: 3.52 nmi	Area:	2378.00
Metric: TALA	Color:	

great number and variety of cultural resources.

In addition to these statutes, several other statutes, executive orders, and presidential memoranda also direct FAA to consult with Native Americans concerning potential impacts on sacred sites and their use for religious purposes. These directives, the consultation process that FAA has followed, and the changes made to avoid impacts, are described in detail in the EA for the Final Rule establishing subpart U.

The EA for the Final Rule establishing subpart U stated that no significant adverse effect was anticipated from adoption of the Special Flight Rules, which in this NPRM are the No Action Alternative. Under the Proposed Alternative (noise efficient aircraft) in this NPRM, noise levels will be reduced further and in areas where noise may have increased as a result of implementing subpart U, noise will be reduced. Therefore, no historic, cultural, or archeological resources are expected to be significantly adversely impacted by either alternative in this NPRM. However, Sec. 106 consultation is continuing.

Visual effects will also be reduced. See Section 4.5.

4.3 DOT SECTION 4(f)

Section 4(f) of the Department of Transportation (DOT) Act, 49 U.S.C. Section 303, requires that the Secretary of Transportation consider certain environmental consequences to public lands if any proposed transportation program or project requires the use of any publicly owned land from a public Park, recreation area, or wildlife and waterfowl refuge of national State, or local significance, or land of a historic site or national, State, or local significance (as determined by Federal, State, or local officials having jurisdiction of the Park, area, refuge, or site), then the Secretary can approve the proposed program or project base only upon a showing that there is no feasible and prudent alternative to using such land and that the program or project includes all possible planning to minimize harm to the Park, recreation area, wildlife or waterfowl refuge, or historic site.

Actions which render Section 4(f) properties unsuitable for the uses occurring at these sites may constitute a "constructive use" of such properties even if no physical taking of property is involved. Noise levels which substantially interfere with the use and value of such properties or preclude the activities normally occurring at such properties would therefore constitute a constructive use of property.

GCNP and adjoining lands are largely public land protected under Section 4(f). The Congress stated in Pub. L. 100-91 that noise associated with aircraft overflights at GCNP was causing "a significant adverse effect on the natural quiet and experience of the Park...."

The proposed action is an effort to address the Congressional concern by further reducing the effects of aircraft noise, including reducing noise which may have increased as a result of the Final Rule establishing subpart U.

The No Action Alternative will maintain noise levels at low levels. The Proposed Alternative will reduce aircraft noise effects. Thus, neither alternative will cause a use (actual or constructive) under DOT Section 4(f) within the initial impact analysis area.

Finally, neither the no action nor the proposed alternative requires the physical use of any lands protected under Section 4(f).

4.4 WILD AND SCENIC RIVERS AND WILDERNESS AREAS

The Wild and Scenic Rivers Act (Pub. L. 90-542, as amended) describes those river areas eligible to be included in a system afforded protection under the Act as free flowing and possessing "...outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values." As described in Section 3 of the Final EA for the Special Flight Rules in the Vicinity of the GCNP, the Colorado River within the Grand Canyon National Park including that portion that forms a boundary with the Hualapai Reservation meets the criteria for designation as a wild and scenic river, and so is treated in accordance with the requirements of the Wild and Scenic Rivers Act.

The Proposed Alternative (noise efficient aircraft) will reduce noise levels further contributing to restoration of natural quiet in the Grand Canyon and including that portion of the Colorado River forming the boundary between the Hualapai Reservation and the GCNP. The No Action Alternative will maintain noise levels at low levels. Noise effects will not increase under either alternative.

The Wilderness Act of 1964, as amended (Pub. L. 88-577, 78 Stat. 890, codified at 16 U.S.C. 1131-36) states that "[a] wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean . . . an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value."

In the vicinity of the Grand Canyon, Saddle Mountain Wilderness Area, located west of Marble Canyon and managed by the U.S. Forest Service, was included in the Bright Angel Flight Free Zone in the Final Rule establishing subpart U. The Arizona Strip, located on the Kaibab Plateau and managed by BLM, has no air tour activity and is outside the SFAR established in the Final Rule. Neither the No Action Alternative nor the Proposed Alternative (noise efficient aircraft) will affect these Wilderness Areas.

A large portion (one million acres) of the GCNP is eligible for or designated part of the National Wilderness Preservation System. The No Action Alternative will maintain noise levels at low levels approaching natural quiet. The proposed alternative will further and significantly reduce noise levels to more closely approach natural quiet, contributing directly to the purposes of the Wilderness Act.

4.5 VISUAL IMPACTS

This impact category is normally related to considerations of the aesthetic integrity of an area in relation to proposed development in residential areas, disruption of scenic vistas, impairment of experience at historic sites, and interference with privacy during ceremonies at Native American sacred sites. Neither the Proposed Alternative nor the No Action Alternative involves physical development or construction.

However, the visual impact of air traffic on the scenic vistas of GCNP and over cultural areas, including sacred sites and historic sites, in the GCNP and surrounding lands is of concern. Air traffic currently traverses areas in the vicinity of the GCNP creating a visual impact as discussed in the EA for the Final Rule establishing subpart U. The nature of these impacts is expected to improve further under the Proposed Alternative (noise efficient aircraft) as compared to the No Action Alternative (Final Rule). The No Action Alternative provides for more concentrated flow in some areas than had previously existed though those changes did not create significant visual impacts. In these areas and elsewhere in the vicinity of the Grand Canyon, the Proposed Alternative would phase out Category A and B aircraft and thereby reduce overflights at least initially since not all Category A and B aircraft will be replaced immediately, if at all, by Category C aircraft. Thus, in the early stages of the phase-out of A and B aircraft, visual intrusions will decrease. In addition the proposed action is not anticipated to increase visual intrusion in the long run because of the operational limitations established in subpart U.

4.6 SOCIAL/SOCIO-ECONOMIC IMPACTS

This impact category is concerned with the physical disruption or division of communities, relocation of residences or businesses, altered surface transportation systems, shifts in population movement or growth, and changes in public service demands or business or economic activity. Of these, the only impact that the proposed action may have relates to business activity. (Environmental justice impacts are considered in the next section.)

For this NPRM, FAA has prepared a Regulatory Evaluation, International Trade Impact Assessment, Unfunded Mandates Assessment, and Regulatory Flexibility Analysis. A detailed summary of these analyses is included in the preamble to the NPRM.

In these evaluations and in the environmental review, the FAA reviewed the costs and benefits, both qualitative and quantitative, to the commercial sightseeing industry, the Park, and Park visitors, using reasonably available data and methods. In particular, the FAA considered impacts on both tribal and non-tribal air tour operations and on tribal and non-tribal interests in the GCNP and its environs. FAA considered the different noise characteristics of helicopters and fixed wing aircraft and in light of those differences whether the proposed noise limitations favored or disfavored helicopters compared to other aircraft. FAA also considered whether the proposed noise limitations favored or disfavored air tour operators compared to other types of sightseeing operations. FAA considered impacts on international trade and on local communities. FAA considered impacts on

access to the Park by those who could not otherwise view the GCNP because of physical limitations and on access by those without such limitations who choose to experience the canyon by other means.

The FAA has determined that the Proposed Alternative (noise efficient aircraft) will significantly affect a substantial number of small entities. However, the Proposed Alternative by phasing in noise efficient operations will reduce the regulatory burden by spreading costs over time while working toward integrating technological advances in reducing noise with the national goal of substantially restoring quiet in the GCNP. At the same time, as a result of the Final Rule, FAA in cooperation with the NPS and other interested parties will develop a 5-year management plan which will provide more information about potential impacts and inform the regulatory process. The 5-year management plan is outlined in Chapter 2 and in the Preamble of the NPRM.

4.7 ENVIRONMENTAL JUSTICE

Executive Order (EO) 12898 (52 FR 7629, Feb. 11, 1994) directs Federal agencies to "identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations...." This includes consideration of such effects on Native American tribes discussed in the next Section 4.2, 4.5, and 4.8.

The EPA's Office of Environmental Justice defines Environmental Justice, in Chapter 1 of its Draft Environmental Justice Guidance (July 12, 1996), as: "The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic group should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies." The EPA further states that the goal is not to shift risks among populations but to identify potential disproportionately high and adverse effects and then to identify alternatives to mitigate these impacts.

Previous consultation with the public and Native Americans is described in the EA for the Final Rule establishing subpart U. Opportunities will be provided for continued public participation and consultation between Native American governments and the U.S. government in developing the Final EA for the proposed amendment to subpart U to phase in noise efficient aircraft.

No areas are expected to receive more noise under the No Action Alternative or the Proposed Alternative to provide for quiet technology. The No Action Alternative will maintain noise levels at low levels. The Proposed Alternative (noise efficient aircraft) will reduce those noise levels throughout the Grand Canyon, and thus contribute to restoring natural quiet in the GCNP, including along the lower end of the Canyon, where the Hualapai Reservation is bounded by the GCNP along the Colorado River and where the Hualapai operate a river rafting enterprise. The Proposed Alternative will also reduce noise in the few other areas

where noise may increase as a result of implementation of subpart U.

4.8 NATIVE AMERICAN COMMUNITIES

Chapter 3 discusses the Native American communities that inhabit the area in and around GCNP. The proposed alternative to phase in noise efficient aircraft makes no changes that are expected to have a significant adverse impact on Native American communities and will, as stated in previous sections, provide noise relief and in certain areas, relief from visual intrusion.

4.9 WILDLIFE RESOURCES

As discussed in Chapter 3, several threatened and endangered species are found in the vicinity of the GCNP. The relatively low levels projected under the No Action Alternative were determined to be not likely to adversely affect either the ground living species or the California condor, American peregrine falcon and the bald eagle. The Proposed Alternative will reduce noise levels, further contributing to restoration of natural quiet in the GCNP and the possibility of disturbing birds during, for example, nesting. And operations are expected to be reduced during the phase in of quiet technology under the Proposed Alternative. As Category A and B aircraft are phased out, not all will be replaced immediately by Category C aircraft.

The California condor, which was recently released at Vermillion Cliffs to the west of Marble Canyon at the upper end of the Grand Canyon, would not be adversely affected by the No Action alternative or by the Proposed Alternative. Vermillion Cliffs was not affected by the Final Rule establishing subpart U since Vermillion Cliffs lies outside Marble Canyon. And within Marble Canyon, which was within the scope of the Special Flight Rules, only one operation occurs and its noise levels are below ambient levels.

The likelihood of adverse effects to the avian endangered species is remote given that, with either alternative, aircraft will not be introduced into new areas and noise levels are low. Under the Proposed Alternative, noise levels will decrease overall. Operations will also decrease, at least initially and then be capped. The Proposed Alternative would therefore further reduce any potential for disturbing birds. The U.S. Fish and Wildlife Service has concurred in the FAA's determination. See Appendix C.

4.10 CUMULATIVE IMPACTS

The evaluation of cumulative impacts considers the cumulative environmental effects of several or multiple impacts over time. While a single project may not cause any significant environmental impacts, the impacts of a series of separate projects may, when accumulated, be significant.

The cumulative impacts of the No Action Alternative will not change. These impacts were evaluated in the Final EA for the December 31, 1996 rule codified in Part 93 Subpart U of Title 14 CFR. The cumulative impacts of the Proposed Alternative would be positive in that noise levels will be reduced throughout the GCNP and vicinity. Visual intrusion may also be reduced as operations decline at least initially during the phase in. The Final EA, with the full environmental analysis, will consider the cumulative impacts of the Proposed

Alternative with those of the past and reasonably foreseeable future actions.

4.11 OTHER IMPACT CATEGORIES

The Environmental Consequences "section forms the scientific and analytic basis for the comparisons" in the alternatives section (see FAA Order 1050.1D, par. 66). FAA Order 1050.1D advises, in essence, that specific environmental impact areas should be discussed "as much as is necessary to support the comparisons [of alternatives]." Accordingly, an early review of the potential environmental impacts was conducted to guide the development of the environmental consequences section. This review indicated that most impact categories typically evaluated in an environmental assessment would not be affected by any of the alternatives. FAA conducted scoping for the proposal to establish subpart U and in that scoping process solicited comments on quiet technology. Scoping comments, including comments received on quiet technology, during this process, confirmed that the the following impact categories would not be affected by any of the alternatives. Therefore, the these impact categories were not analyzed in detail:

- Coastal Zone
- Water Quality
- Wetlands
- Coastal Barriers
- Light Emissions
- Air Quality
- Biotic Communities
- Floodplains
- Farmland
- Solid Waste
- Bird Hazard
- Energy/Natural
- Construction
- Compatible Land Use

[1] Because tour aircraft fly only during the 12 hour period, L_{dn} is equal to L_{Aeq12h} minus 3 dB.

[2] The INM profile generator is based on recommendations found in the Society of Automotive Engineers' Aerospace Information Report 1845 (SAE AIR 1845).[11] It presents an empirical method for computing aircraft position and performance, using a set of aerodynamic and engine coefficients unique to each aircraft model. These coefficients, along with the standard procedure for each aircraft exist in INM as an automated profile generation utility.

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APPENDIX B

COMPARISON OF MEASURED AND INM-PREDICTED NOISE AT GCNP

One of the reasons for selecting the INM for analyzing noise at the Grand Canyon was the close correlation between the model's predictions and actual measurements taken at the Park. This appendix contains the report from the study conducted by the Volpe National Transportation Systems Center in Cambridge, MA, for the Office of Environment and Energy (VNTSC Letter Report DTS-75-FA465-LR11, "Comparison of Measured and Predicted Noise Levels in Grand Canyon National Park, August 1994). The study compares INM results with data provided by Harris, Miller, Miller, and Hanson, Inc.

U.S. Department
of Transportation

**Research and
Special Programs
Administration**

Memorandum

Subject: Comparison of Measured and Predicted Noise Levels in Grand Canyon National Park Letter Report: DTS-75-FA465-LR11

Date: August 9, 1994

From: Gregg G. Fleming *Gregg G. Fleming*

Reply to Attn. of: DTS-75

To: Thomas L. Connor; FAA, AEE-100

This letter report presents the results of comparisons between measured and predicted noise levels in the vicinity of Grand Canyon National Park (GCNP). The attached Figures 2 through 4 present the results of comparisons between measured and predicted sound exposure levels (SEL) for individual flyover operations. Tables 1 through 5 present the results of comparisons between measured and predicted equivalent sound levels (L_{eq}) for composite, hourly operations. The measured SEL and L_{eq} data were provided to the Volpe Center by Harris Miller Miller and Hanson Inc (HMMH). These data were obtained during two separate time periods at five sites in GCNP as shown in Figure 1. Sites 1 and 2 (separated by less than 2000 ft) were the SEL measurement sites. Sites 3, 15, and 16 were the hourly L_{eq} measurement sites.

The comparative predicted values were obtained by the Volpe Center using a modified version of the Integrated Noise Model (INM) Version 4.11. The modified version of the INM neglects the effects due to lateral attenuation. This modification is considered appropriate for predictions at the five sites examined in the current study due to their close proximity to the rim of the Canyon. In addition, the terrain beneath the source-to-receiver propagation path for the five sites is primarily hard-packed sand and rocks - a surface which lends itself to little if any over-ground attenuation. The specific methodology for computing aircraft flight tracks, and takeoff and approach profiles is outlined in the previous Volpe Center Letter Report DTS-75-FA465-LR8.

Comparison of Measured and Predicted SEL

Figure 2 graphically displays the measured SEL data, linear regression line drawn through the data, and the associated 90 percent confidence interval (CI) as a function of slant distance for the DeHavilland DHC-6 Twin Otter aircraft. Although the SEL data were measured at two sites (Sites 1 and 2 as shown in Figure 1) no distinction is made in Figure 2. Also displayed is the INM-predicted SEL and the adjusted-predicted SEL as a function of slant distance. The predicted SEL was computed at two slant distances representing the approximate extremes

of the measured slant distances. It was assumed that the predicted SEL was a linear function of slant distance between these points. The specific slant distances were achieved in the INM input file by varying the SFAR 50-2 flight tracks in the horizontal plane while holding the prescribed altitudes constant. The adjusted-predicted SEL was then obtained by subtracting a constant 5 dB, regardless of slant distance, from the INM-predicted SEL. The 5 dB adjustment is an estimate of the noise reduction associated with the quiet propellers installed on the DHC-6 aircraft operating at GCNP. As can be seen there is good agreement between the measured and the adjusted-predicted SEL for the DHC-6 aircraft (the adjusted-predicted conservatively overstates the measured noise by approximately 3 dB regardless of slant distance). However, the two data sets are statistically different.

Figure 3 graphically displays the measured SEL data, linear regression line drawn through the data, and the associated 90 percent CI as a function of slant distance for the Cesna Models 182, Stationair 6/7/8, and 414A aircraft. Although the SEL data were measured at two sites (Sites 1 and 2 as shown in Figure 1) no distinction is made in Figure 3. Also displayed is the INM-predicted SEL as a function of slant distance. The predicted SEL was computed at two slant distances representing the approximate extremes of the measured slant distances. It was assumed that the predicted SEL was a linear function of slant distance between these points. The specific slant distances were achieved in the INM input file by varying the SFAR 50-2 flight tracks in the horizontal plane while holding the prescribed altitudes constant. In computing the predicted SEL for these aircraft, the noise curves and performance information for the Beechcraft Model 58P were utilized. This was considered reasonable based on an evaluation of available data in the INM Data Base and previous FAA studies. As can be seen there is good agreement between the measured and the INM-predicted SEL for the Cesna aircraft (the predicted conservatively overstates the measured noise by approximately 2 dB regardless of slant distance). However, the two data sets are statistically different.

Figure 4 graphically displays the measured SEL data, linear regression line drawn through the data, and the associated 90 percent CI as a function of slant distance for the Bell Models 206 and 206L, and the Aerospatiale Model 350/355 helicopters. Although the SEL data were measured at two sites (Sites 1 and 2 as shown in Figure 1) no distinction is made in Figure 4. Also displayed is the INM-predicted SEL as a function of slant distance. The predicted SEL was computed at three slant distances representing an intermediate point and the approximate extremes of the measured slant distances. It was assumed that the predicted SEL was a linear function of slant distance between these points. The specific slant distances were achieved in the INM input file by varying the SFAR 50-2 flight tracks in the horizontal plane while holding the prescribed altitudes constant. In computing the INM-predicted SEL for these helicopters, the noise curves in the Heliport Noise Model (HNM) for the centerline-flyover and left-flyover configuration (depending upon the position of the helicopter relative to the site) of the Bell 206L were utilized. This was considered reasonable based on an evaluation of available data in the HNM's Data Base. The predicted values computed by the INM were then normalized

to a nominal flyover speed of 90 kts (considered typical for tour operations at GCNP according to C.R. Cox at Bell Helicopter) by adding a constant 1.1 dB, regardless of slant distance. As can be seen there is good agreement between the measured and the predicted SEL (the predicted conservatively overstates the measured noise by approximately .5 dB). In addition, for most slant distances the two data sets are statistically equivalent.

Comparison of Measured and Predicted Hourly L_{eq}

Tables 1 through 5 present a comparison of the measured and predicted hourly L_{eq} for Measurement Sites 3, 15, and 16 (See Figure 1 for measurement site locations). The predicted hourly L_{eq} for the three measurement sites was computed using the output from the detailed grid report generated by the INM. Specifically, the SEL values for the most significant propeller flight and the most significant helicopter flight were used in conjunction with the number of operations (as logged by HMMH) to compute the predicted hourly L_{eq}. For example, in Table 1, at 10:00, two propeller-driven aircraft and 22 helicopters were logged. The INM predicted the SEL for the most significant propeller flight to be 64.8 dB, and the SEL for the most significant helicopter flight to be 65.3 dB. The hourly L_{eq} (neglecting jet aircraft operations) was then computed as follows:

$$L_{eq,1hr}^{*} = 10\log\{\text{Alog}[(64.8 + 10\log(2))/10] + \text{Alog}[(65.3 + 1.1 + 10\log(22))/10]\} - 35.6$$

where 1.1 = constant speed correction which normalizes the helicopter SEL in the HNM Data Base from a speed of 117 kts to a speed of 90 kts; and

35.6 = constant which normalizes the L_{eq} to a 1-hour time period, (i.e., 10log(1/3600 sec) equals -35.6.

$$L_{eq,1hr}^{*} = 44.5 \text{ dB}$$

* Jet aircraft operations were neglected in the computation of the predicted hourly L_{eq}.

As can be seen the agreement between the measured and predicted hourly L_{eq} was quite good for Sites 3 and 15 (Tables 1 through 3). Taking into consideration all hours for which measured-versus-predicted comparisons were made, the average difference (predicted minus measured) was 1.7 dB, i.e., the INM conservatively overstated the noise by 1.7 dB. There are some hours where the INM underpredicted the noise, e.g., Table 1, Hours 10:00 and 11:00, and some hours where the INM overpredicted the noise by a fairly significant amount, e.g., Table 3, Hours 14:00 and 16:00. These anomalies are likely due to: (1) the lack of knowledge regarding the aircrafts' dispersion from the nominal flight track; and to a lesser degree (2) the specific aircraft type represented by the measured data.

There is a general lack of agreement between the measured and predicted hourly L_{eq} for Site 16 (Tables 4 and 5). In fact, the predicted values consistently overstate the noise at Site 16 by an average of 9.9 dB. This overprediction is a result of the source-to-receiver geometry at the measurement site. According to HMMH, for most aircraft pass-bys at Site 16, the rim of the Canyon formed a barrier between the aircraft and the microphone; and the barrier was only broken occasionally. Since the INM currently does not account for barrier attenuation, a fairly significant overprediction was expected. The 9.9 dB overprediction appears reasonable since a simple break in the line-of-site (from source-to-receiver) typically results in a 5 dB reduction in sound level at the receiver.

If you have any comments or questions please do not hesitate to contact me.

Attachments

cc: J.A. Plante; AEE-120
D.G. Warren; AEE-120
R.D. Horonjeff; HMMH
C.R. Cox; Bell

Figure 1: GCNP Site Locations

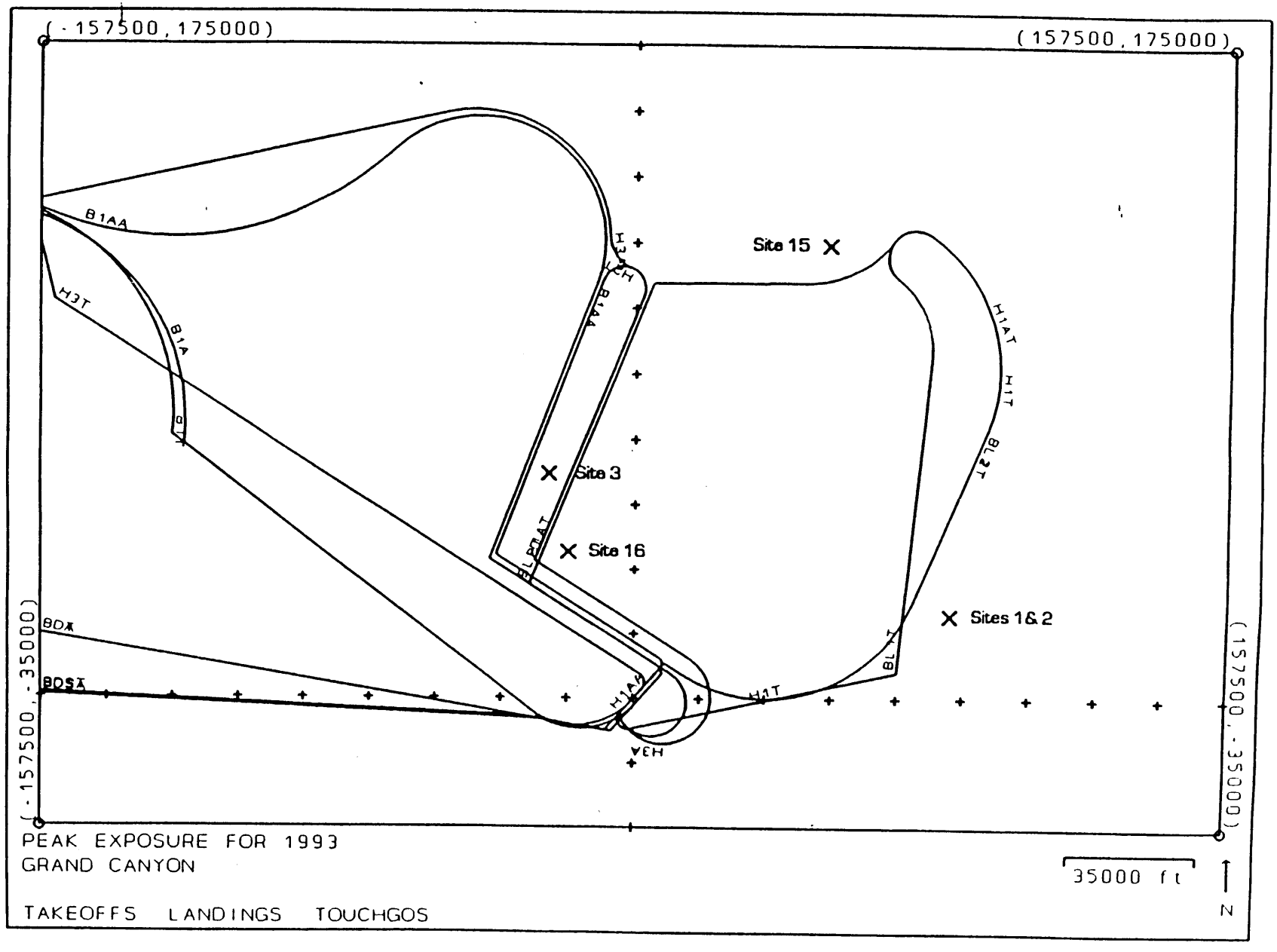

Figure 2: DeHavilland DHC-6 Twin Otter
SEL vs Slant Distance

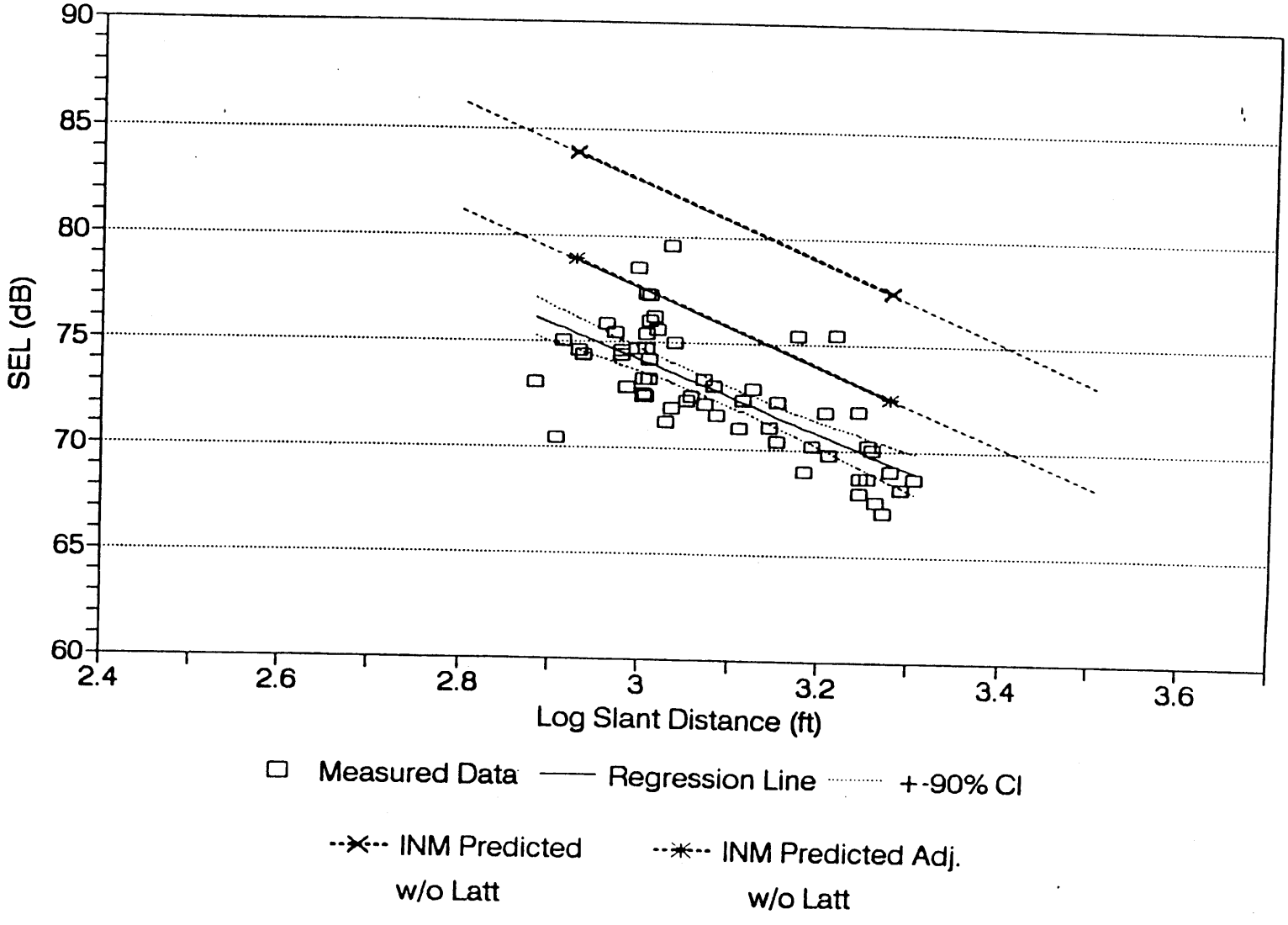

Figure 3: Cessna
SEL Versus Slant Distance

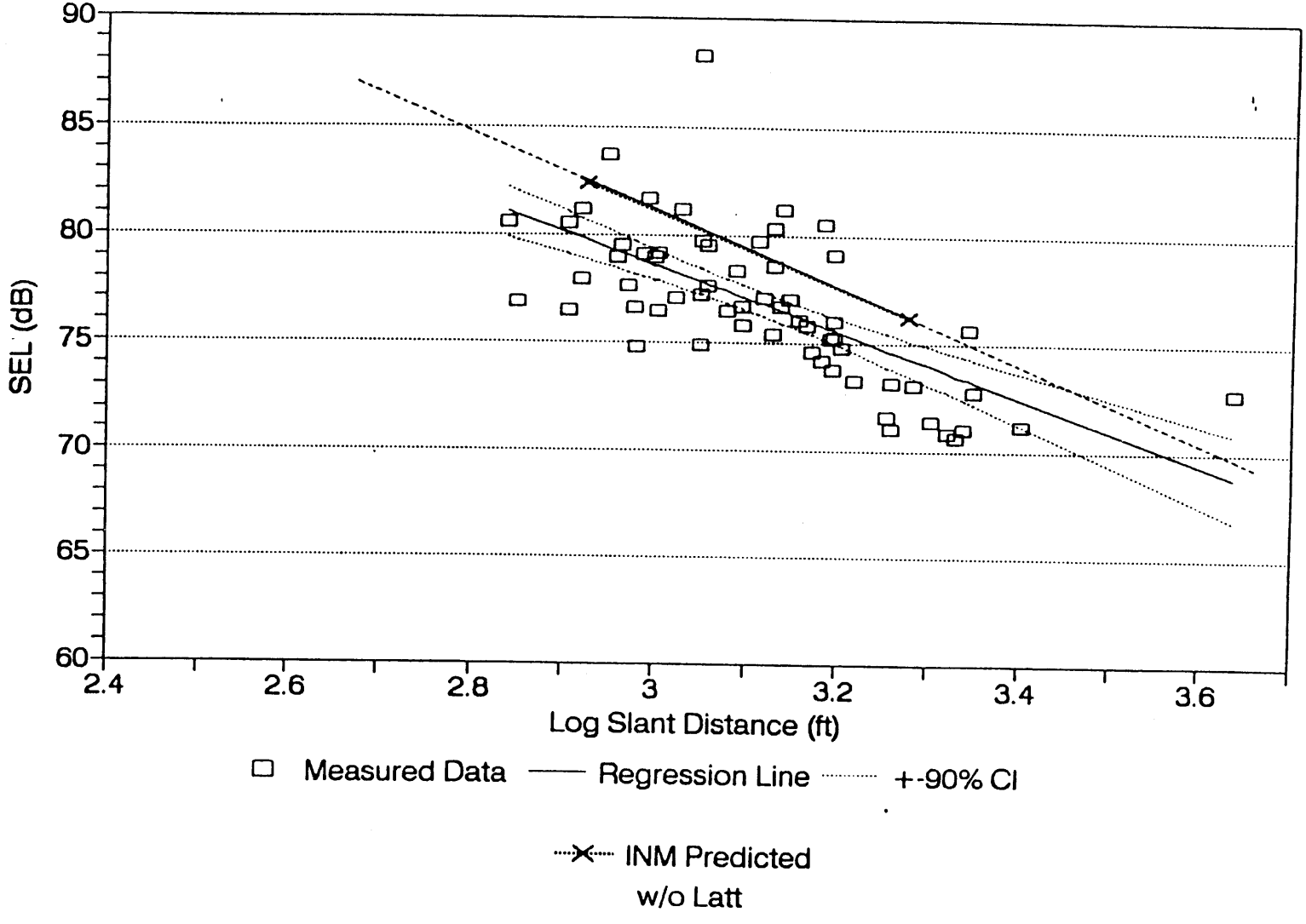

Figure 4: Helicopters
SEL Versus Slant Distance

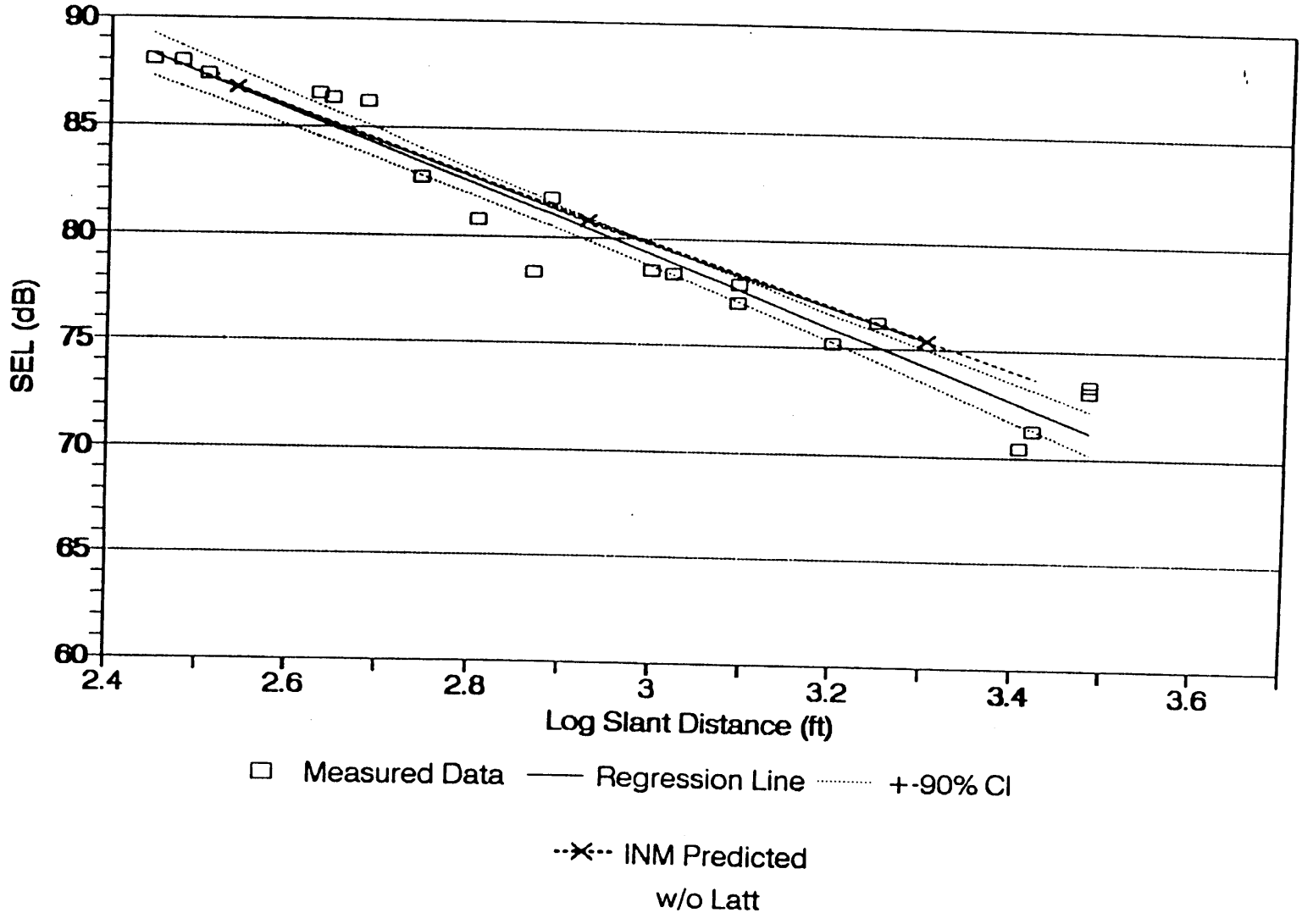

Table 1. Comparison of Measured and Predicted Hourly Leq's for Site 3, 30-Aug-1992

Hour Beginning At	Estimated Traffic Counts				Measured Aircraft Leq (dB)	Predicted Aircraft Leq* (dB)	Difference (Pred. - Meas.)
	Props	Helos	Jets*	Total			
10:00	2	22	1	25	46.9	44.5	-2.4
11:00	5	16	1	22	46.2	43.7	-2.5

Table 2. Comparison of Measured and Predicted Hourly Leq's for Site 15, 5-Sep-1992

Hour Beginning At	Estimated Traffic Counts				Measured Aircraft Leq (dB)	Predicted Aircraft Leq* (dB)	Difference (Pred. - Meas.)
	Props	Helos	Jets*	Total			
11:00	13	1	0	14	37.7	40.4	2.7
13:00	6	1	1	8	36.2	37.3	1.1
14:00	6	4	3	13	36.3	38.3	2.0
15:00	6	3	1	10	35.6	38.0	2.4
16:00	13	3	0	16	39.0	40.7	1.7

Table 3. Comparison of Measured and Predicted Hourly Leq's for Site 15, 6-Sep-1992

Hour Beginning At	Estimated Traffic Counts				Measured Aircraft Leq (dB)	Predicted Aircraft Leq* (dB)	Difference (Pred. - Meas.)
	Props	Helos	Jets*	Total			
10:00	9	2	4	15	37.1	39.1	2.0
11:00	8	6	0	14	37.9	39.6	1.7
12:00	2	1	7	10	33.4	33.2	-0.2
13:00	7	1	3	11	36.1	37.9	1.8
14:00	6	1	2	9	30.7	37.3	6.6
16:00	12	1	4	7	34.6	40.1	5.5

* Jet Aircraft operations were neglected in the computation of predicted Leq.

Table 4. Comparison of Measured and Predicted Hourly Leq's for Site 16, 25-Aug-1992

Hour Beginning At	Estimated Traffic Counts				Measured Aircraft Leq (dB)	Predicted Aircraft Leq* (dB)	Difference (Pred. - Meas.)
	Props	Helos	Jets*	Total			
12:00	4	11	5	20	35.1	45.3	10.2
13:00	8	7	7	22	35.9	45.2	9.3
14:00	9	14	1	24	34.3	47.1	12.8

Table 5. Comparison of Measured and Predicted Hourly Leq's for Site 16, 1-Sep-1992

Hour Beginning At	Estimated Traffic Counts				Measured Aircraft Leq (dB)	Predicted Aircraft Leq* (dB)	Difference (Pred. - Meas.)
	Props	Helos	Jets*	Total			
09:00	9	12	7	28	37.5	46.7	9.2
10:00	10	17	7	34	41.2	47.8	6.6
11:00	6	9	3	18	35.8	45.2	9.4
12:00	8	11	5	24	35.9	46.2	10.3
13:00	7	7	5	19	35.1	44.9	9.8
14:00	3	9	4	16	33.1	44.3	11.2

* Jet Aircraft operations were neglected in the computation of predicted Leq.

APPENDIX C

CORRESPONDENCE AND COMMENTS FROM AGENCIES

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In Reply Refer To:
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2-21-97-I-085

December 17, 1996

Dr. Ann Hooker
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OPTIONAL FORM 99 (7-90)
FAX TRANSMITTAL # of pages ▶ 2
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Dept./Agency Phone # 602/640-2720
Fax # 202/267-5594 Fax # 602/64-2730
NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

Dear Dr. Hooker:

This letter is in response to your request of December 16, 1996, for review, comment, and concurrence of affects for the Special Flight Rules in the Vicinity of Grand Canyon National Park, which creates a new subpart U of part 93 of 14 CFR. The California condor (Gymnogyps californianus) was recently reintroduced in the vicinity of Grand Canyon National Park under the provisions of Section 10(j) of the Endangered Species Act. As a nonessential experimental population, this population of California condors is managed in accordance with appropriate regulation and the special rules included as part of the final rule establishing the nonessential experimental designation for portions of northern Arizona and southern Utah (61 FR 54044; October 16, 1996). The Federal Aviation Administration has made a determination of "may effect, not likely to adversely affect" for the California condor.

The U.S. Fish and Wildlife Service has reviewed the "Draft Environmental Assessment to the Noise Limitations for Aircraft Operations in the Vicinity of the Grand Canyon National Park, Transition to Quiet Technology," dated December 1996. The proposed action would limit air traffic in some areas and increase air traffic and related noise levels in other areas. The environmental assessment briefly reviewed the potential effects of noise disturbance to California condors assessing potential impacts only from the baseline of the current FAA regulations to the standards imposed with the new regulations. The Service concurs with FAA's finding of "may effect, not likely to adversely affect" for the California condor. This concurrence is based on the factors detailed in the final rule establishing this nonessential experimental population of California condors, and includes consideration of the lack of documented bird/aircraft collisions over the Grand Canyon, the expected flight patterns of the California condor, and the flight ceilings as imposed by FAA regulation.

Thank you for your consideration of the conservation of the California condor as part of your proposed action. In future communications on this project, please refer to consultation number 2-21-97-I-085. If we may be of further assistance, please contact Bruce Palmer or Tom Gatz.

Sincerely,

Sam F. Spiller
Field Supervisor

cc: California Condor Recovery Coordinator, Ventura, CA.
Chief (DES), Fish and Wildlife Service, Arlington, VA (Attn: Renne Lohoefener)

APPENDIX D GLOSSARY

A-weighted Decibel (dBA) -- An acoustic unit of measure which approximates the frequency response of the human ear.

A-weighting -- The sound pressure level which has been filtered or weighted to approximate the human ear's perception of sound.

AEE -- FAA Office of Environment and Energy.

AEM -- Area Equivalent Method.

AGL -- Above Ground Level.

Air Carrier -- A company engaged in providing scheduled commercial air transportation services.

Aircraft Categories (A,B,C) -- GCNP Category A aircraft means an aircraft that has not been shown to comply with the GCNP Category B or GCNP Category C noise limit.
GCNP Category B aircraft means an aircraft that has been shown to comply with the GCNP Category B noise limit but not the GCNP Category C noise limit.
GCNP Category C aircraft means an aircraft that has been shown to comply with the GCNP Category C noise limit.

Air Route Traffic Control Center (ARTCC) -- An FAA facility established to provide air traffic control service to aircraft operating on an IFR flight plan within controlled airspace during the enroute portion of a flight.

Air Traffic Control (ATC) -- Division of the Federal Aviation Administration responsible for the safe guiding of pilots in their transit of airspace and on the ground at towered airports.

Airport Master Plan -- A long-term (usually 20-year) comprehensive development plan for an airport. Typical elements of a Master Plan include: activity forecasts, airport layout plan, development recommendations with cost estimates and an environmental overview.

Approach Control Descent Area (ACDA) -- Airspace restrictions established to provide for the separation of landing aircraft from departing aircraft.

Approach Procedure -- A general procedure for how an aircraft comes in for a landing at an airport. Includes both visual and instrument approaches.

Day-Night Average Sound Level (DNL or L_{dn}) -- The Federal Aviation Administration's standard noise descriptor, measured in A-weighted decibels (dBA), that represents a cumulative, integrated, average sound level. Based on the equivalent A-weighted sound level (L_{eq}) with a 10-decibel penalty for noise events in the nighttime hours (10:00 p.m. to 7:00 a.m.).

dB -- See Decibel.

dBA -- See A-weighted Decibel.

Decibel (dB) -- The smallest unit of measure of acoustic energy that a person can distinguish. A doubling of loudness is generally approximated by a change of about 10 decibels. A doubling of acoustic energy occurs at 3 decibels.

Departure Procedure -- A general procedure for how an aircraft takes off and climbs to a designated altitude. There are various generalized and specialized departure procedures. Procedures usually describe various velocities, altitudes, or rates of climb that are benchmarks to be followed.

Departure Profile -- The two-dimensional description (altitude and distance from brake release) of the aircraft departure trajectory. Various points along the trajectory may be associated with specific departure procedures.

DNL -- See Day-Night Average Sound Level.

DOI -- U.S. Department of the Interior

DOT -- U.S. Department of Transportation.

Equivalent A-weighted Sound Level (L_{eq}) -- The average (on an energy basis) noise level integrated over some specified period of time.

FAA -- Federal Aviation Administration (part of the U.S. Department of Transportation).

FAAct – Federal Aviation Act of 1958.

FAR -- See Federal Aviation Regulations.

Federal Aviation Regulations (FAR) -- The body of Federal regulations relating to aviation. Published as Title 14 of the Code of Federal Regulations.

Flight Heading -- The direction in which the nose of the airplane points during flight; this is usually expressed by reference to a compass reading from 1° to 360°.

Flight Track -- The path along the ground followed by an aircraft in flight.

GCNP -- Grand Canyon National Park unit of the National Park Service.

General Aviation (GA) -- All civil aviation except commercial carriers.

Glide Slope (GS) -- An instrument landing system facility providing vertical guidance for aircraft during approach and landing.

Head-to-head Operations -- Taking off in one direction and landing in the opposite direction.

IFR -- See Instrument Flight Rules.

IWG – Interagency working group of the DOT and DOI.

Instrument Approach -- An approach to a landing area guided by instruments in the aircraft and on the ground, as opposed to a visual approach.

Instrument Flight Rules (IFR) -- Federal procedures, using instruments in the aircraft and on the ground, which pilots must follow when weather conditions are below the minimums prescribed for visual flight conditions (see also Visual Flight Rules).

ILS -- See Instrument Landing System.

Instrument Landing System (ILS) -- Instrument landing aid providing altitude and directional guidance.

Instrument Meteorological Conditions (IMC) -- Weather conditions expressed in terms of visibility, distance from clouds, and cloud ceilings during which all aircraft are required to operate using instrument flight rules (IFR).

Integrated Noise Model (INM) -- The Federal Aviation Administration-specified computer model for assessing aircraft noise impacts.

Knots -- Airspeed measured as the distance in nautical miles covered in 1 hour.

L_{10} -- The sound level exceeded 10 percent of the time.

L_{90} -- The sound level exceeded 90 percent of the time.

L_{AE} -- Sound exposure level.

L_{AEq12h} -- Equivalent sound level over a 12-hour time period.

L_{dn} -- See Day-Night Average Sound Level.

L_{eq} -- Equivalent A-weighted sound level. Equivalent sound level, L_{eq}, is the energy average noise level (usually A-weighted) integrated over some specified time. Equivalent signifies that the total acoustical energy associated with the fluctuating sound (during the prescribed time period) is equal to the total acoustical energy associated with a steady sound level of L_{eq} for the same period of time. The purpose of L_{eq} is to provide a single number measure of noise averaged over a specified time period.

L_{max} -- Maximum A-weighted sound level.

Mean Sea Level (MSL) -- The average height of the surface of the sea for all stages of the tide, used as a reference for elevations. Also called sea level datum.

NPRM – Notice of Proposed Rulemaking.

NPS – National Park Service of the U.S. Department of the Interior.

Nautical Mile -- A measure of distance equal to 1 minute of arc on the earth's surface (approximately 6,000 feet).

NAVAIDS -- Visual and electronic aids to air navigation.

Noise Abatement -- Measures taken to reduce the off-airport impacts of aircraft noise.

Noise Contour -- A line depicting equal levels of sound exposure, usually drawn on a base map of the area.

Operation -- A landing or a takeoff by an aircraft.

Part 36 -- FAR Part 36 establishes the aircraft noise certification sound levels and associated requirements for certificated aircraft.

Part 91 -- FAR Part 91 are general operating rules which include a schedule for all air carrier jets to meet FAR Part 36 Stage 3 requirements.

Precision Approach Path Indicator (PAPI) -- A landing aid which provides visual approach slope guidance to a runway.

Preferential Runway System (PRS) -- A system of runway use which attempts to route as much traffic as possible over the least noise-sensitive areas around the airport.

SFAR -- Special Federal Aviation Regulation.

SFRA -- Special Flight Rules Area.

Sound Exposure Level (SEL) -- A measure of the total sound energy of an event taking into account amplitude, frequency, and duration.

Stage 1, 2, 3 Aircraft -- Classification of aircraft based on noise emissions, as defined in Federal Aviation Regulation Part 36. Stage 1 aircraft are the noisiest; Stage 3 are the quietest.

TA -- see Time Above.

TACAN -- Tactical Air Navigation. A navigational system used by the military. TACAN provides both azimuth and distance information to a receiver on board an aircraft.

Time Above (TA) – The TA metric provides the duration in minutes for which aircraft related noise exceeded specified A-weighted sound levels. Further, TA can be related directly to some "threshold activated" physiological or annoyance events.

Turboprop Aircraft -- An aircraft whose main propulsive force is provided by a propeller driven by a gas turbine. Additional propulsive force may be provided by gas discharged from the turbine exhaust.

VFR -- See Visual Flight Rules.

Visual Approach -- An approach to a landing area following visual flight rules.

Visual Approach Slope Indicators (VASI) -- A landing aid which provides visual approach slope guidance to a runway.

Visual Flight Rules (VFR) -- Federal procedures which pilots may use when weather conditions are above the minimums prescribed for visual flight conditions. Under these rules, pilots may fly with visual reference to the ground and without reference to radio navigational aids (see also Instrument Flight Rules).

Visual Meteorological Conditions (VMC) -- Weather conditions equal to or greater than those specified in 14 CFR 91.155 for aircraft operations under Visual Flight Rules (VFR).

VORTAC -- Very High Frequency Omnidirectional Range with Tactical Air Navigation. A navigational radio station which provides magnetic bearing and distance (DME) from the station. The most common form of radio navigation currently in use.

Wetlands -- Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Wilderness -- The Wilderness Act (1964) defines wilderness as areas that:

- Are affected primarily by the forces of nature, where man is a visitor who does not remain.
- Possess outstanding opportunities for solitude or a primitive and unconfined type of recreation.
- Are undeveloped, federally-owned, and generally over 5,000 acres (2,020 hectares) in size.
- Are protected and managed as to allow natural ecological processes to operate freely.
- May contain ecological, geological, or other features of scientific, educational, scenic, or historical value.
- Are formally designated by Congress as wilderness.

APPENDIX E NOISE BASICS

This appendix provides a brief general description of noise and sound, describes the specific metrics used in this study, and finally gives a derivation of the relationship between $L_{eq(12)}$ and speech intelligibility referenced in the text of the noise section.

1. Description of Sound or Noise

Metrics used to quantify sound or noise are based on three characteristics of sound waves:

Level - the sound's amplitude, which is related to loudness;

Frequency Distribution - the pitches that make up a sound; and

Time History - the variations of the sound over time.

Level

A sound wave is the rapid movement of air molecules back-and-forth about an equilibrium position and may be thought of as a wave that propagates away from a noise source at the speed of sound. The greater the back-and-forth motion, the greater the amplitude and the louder the sound. This motion causes increases and decreases in air pressure, and it is these changes in pressure that may be thought of as moving the ear drum and causing sound to be heard.

The ear, however, responds both to very slight and relatively great changes in pressure; in fact, the difference between the quietest sounds that can commonly be heard and the loudest sounds that can be tolerated is a factor of more than one million in terms of pressure. These great differences between quiet and loud sounds are described in terms of the decibel (dB). The decibel scale is based on logarithms and compresses a sound pressure range of one million to a decibel range of 0 dB to 120 dB. When sounds are quantified in decibels, they are referred to as levels. Thus, a sound has a level of 80 dB, or a noise source may be said to produce a sound level of 80 dB.

Frequency Distribution

Noises having equal levels can have different pitches. Pitch or frequency is a measure of how rapidly the air molecules move back-and-forth, and is denoted as cycles per second or as hertz, (Hz). The human ear's ability to hear sound depends upon the frequencies present. We hear best the frequencies present in speech, generally 1,000 Hz to 8,000 Hz and less well the frequencies outside this range. In order to measure sounds in a way that corresponds to human perception, an electronic "weighting" network was designed into sound-measuring instruments. Levels measured with such an instrument are called A-weighted levels (dBA).

Time History

Sound levels vary as time passes. The variations can occur over very short periods or variations can be longer term. During one hour several arriving aircraft may pass by and, during another hour, no aircraft will pass by. Several methods have been used to quantify time-varying noises, but the most common is the equivalent sound level (L_{eq}). This sound level accounts for all sounds that occur in a given time period. Briefly, it is the level of a constant A-weighted sound that has exactly the same amount of total sound energy as did the actual time-fluctuating sound. L_{eq} is equivalent to an actual time-varying sound level in the sense that it has the same total energy for the same length of time, only the fluctuations in level have been summed up to yield a constant, steady-state level.

Thus, the A-weighted sound level can be used to measure instantaneous sound levels as they occur, or the A-weighted level can be cumulative over a longer time period to yield an equivalent level. The instantaneous A-weighted levels are useful for quantifying sound produced by single events, such as the second-to-second levels produced by a passing truck or aircraft or the maximum level produced during an aircraft overflight. The equivalent level is better for quantifying long-term noise exposure.

2. Sound Metrics

The primary metrics used in this study are of two types: one that quantifies how much of the time aircraft will be audible by park visitors engaged in recreational activities; one that sums all the sound energy produced by tour aircraft during a 12 hour period. As a supplemental metric, a measure of the loudest sound occurring during the overflight of a single aircraft is also used.

Audibility

The appendix "A Comparison of A-weighted Signal-to-Noise Ratios and Detectability Metrics for Aircraft Noise" discusses audibility of sounds in some detail. In general, whether or not a person hears and is aware of an intruding sound depends upon the level and frequency content of the sound, the level and frequency of other sounds (often referred to as the "ambient" sound), and whether the listener is engaged in some activity other than listening intently for the intruding sound.

Research conducted by the National Park Service[1] has shown that park visitors can be disturbed by the sound of aircraft, that the degree of this disturbance tends to be correlated with the amount

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[1] Anderson, G.S., *et al*, "Dose-Response Relationships Derived from Data Collected at Grand Canyon, Haleakala and Hawaii Volcanoes National Parks," NPOA Report No. 93-6, October 1993.

Baumgartner, R.M., Cary McDonald, "Aircraft Management Studies, Grand Canyon Visitor Survey," NPOA Report No. 93-5, January 1994.

of time aircraft are audible, and that visitors who go to easily accessible sites such as overlooks tend to be less disturbed than visitors who take hikes away from easily accessed areas. As a result of these findings, and consistent with the NPS objective to substantially restore natural quiet, the metric of percent of the time aircraft are audible was selected to measure the effects of aircraft sound on Grand Canyon National Park.

Because determining audibility rigorously requires frequency content information, the INM, using only A-weighted levels, cannot directly compute this metric. However, as described in the appendix "A Comparison of A-weighted Signal-to-Noise Ratios and Detectability Metrics for Aircraft Noise", an empirical relationship between A-weighted differences and audibility was derived. In essence, when the aircraft produced A-weighted level is roughly the same magnitude as the average non-aircraft or ambient A-weighted level, visitors are likely to notice the aircraft. The INM can compute the amount of time, and hence the percent of a given time interval, that an aircraft sound level exceeds an identified "threshold" level. By using detailed information about ambient levels as the threshold levels, the INM was used to compute the percent of time aircraft sounds exceed ambient sounds. The FAA chose to use as threshold levels the ambient plus 3 dB.

Twelve Hour Equivalent Level, $L_{eq(12)}$

Analyses of aircraft noise effects traditionally use equivalent levels, L_{eq}. As discussed above, equivalent levels are a measure of the total sound energy that occurs during a given period of time. Because all tour operations occur within a twelve hour period, the INM was used to compute the equivalent level for this period, $L_{eq(12)}$.

Day-Night Average Sound Level, DNL

The day-night average sound level (L_{dn} or DNL) is an A-weighted equivalent level that accounts for all sound energy occurring over a 24-hour period. DNL treats all noise events occurring between 10 PM and 7 AM (nighttime) as if they were 10 dB louder than they actually were. This 10 dB penalty is intended to account for increased human sensitivity to nighttime noise. DNL may be computed from L_{eq} values by first adding 10 dB to all L_{eq}s which occur at night and then summing the energy over 24 hours.

DNL is the metric specified by FAA in 14 CFR Part 150 for assessment of the effects of aircraft noise, and it is used in this study to judge impacts that occur outside of the park. It was not computed directly, but it is equal to $L_{eq(12)}$ minus 3 dB. Hence, DNL 65 dB, the criterion for significant impact, occurs where $L_{eq(12)}$ equals 68 dB.

Maximum Sound Level, L_{max}

McDonald, C.D., *et al*, "National Park Service Aircraft Management Studies, Visitors Survey," NPOA Report No. 94-2. January 1995.

As a supplemental metric, the maximum sound level produced by an aircraft overflight was used. It can be related to speech interference since there are well-established relationships between speech intelligibility and intruding sound levels.

Interpreting Changes in Sound Metrics

Changes in Single Event Levels

People have difficulty judging the absolute magnitude of a noise but are much more reliable at judging the relative magnitudes of two sounds. The barely noticeable difference between two sounds when compared sequentially in a laboratory setting is 0.5 to 1.0 dB, depending on the characteristics of the sounds and the absolute level[2]. On the other hand, for clinical audiometry (hearing tests), a difference of 5 dB is used as the minimum difference between tones presented for comparison because the use of smaller differences produced less reliable comparisons. Thus, little significance can be attributed to a difference of 1 dB to 2 dB between sounds, while differences of 5 dB or more can be considered readily noticeable. For single noise events, the following guidelines are offered.

Single Event Noise Level Changes (L_{max})

Change in Level	Expected Reaction to Change
0 dB to 2 dB	Generally not noticeable
2 dB to 5 dB	May be noticeable
5 dB or more	Generally noticeable

Changes in DNL or $L_{eq(12)}$

Determining the probable noticeability of a change in cumulative metrics (DNL or $L_{eq(12)}$) is more complex than interpreting changes in single events. First, there is little published data that give the effects on communities of changes in cumulative levels. Second, it is likely that changes that occur slowly over many years are less likely to be noticed than changes that occur suddenly in a day's or few week's time. Third, reaction to noise depends not only upon the level of the noise, but on people's perceptions of the noise and the noise maker. If people understand and accept the need for the change that resulted in an increase in noise, there may be greater acceptance of (and less reaction to) the noise increase than if the change is regarded as unnecessary or improper. With these considerations in mind, the following interpretation guidelines are offered:

Cumulative Noise Level Changes (DNL or $L_{eq(12)}$)

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[2] Small, A. and Gales, R. "Hearing Characteristics," Chapter 17 of "Handbook of Acoustical Measurements and Noise Control, 3rd Edition," edited by Cyril Harris, McGraw Hill, 1991.

Change in Level	Expected Reaction to Change
0 dB to 2 dB	May be noticeable
2 dB to 5 dB	Generally noticeable
5 dB or more	Change in community reaction likely